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Towards a better understanding of the role of temperament in eating disorders

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Dankwoord

Hier is het dan, mijn ‘proefschrift’. In mijn laatste master psychologie is het allemaal begonnen, zou ik kunnen zeggen. Mijn interesse in eetstoornissen was er al, en toen kreeg ik de kans om zowel een masterproef te schrijven rond eetproblemen alsook stage te lopen op het Centrum voor Eetstoornissen van het UZ Gent.

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Chapter 1: Introduction

Eating disorders are severe mental disorders that often develop during adolescence and may persist into adulthood. Despite the large amount of research aimed at understanding their development and course, plenty of unanswered questions remain. A promising research field regarding this topic suggests that several temperament traits may function as vulnerability and maintaining factors. Especially the role of the traits Sensitivity to Punishment (SP) and Sensitivity to Reward (SR) seems of particular importance to understand the extreme avoidance and approach behaviour that is seen in patients with eating disorders, such as the symptoms of extreme restriction or the frequent occurrence of binge eating episodes. Consequently, the general goal of the studies presented in this dissertation was to increase our insight into the role of SP and SR in eating disorders.

This introduction attempts to provide a general overview of the current scientific knowledge on eating disorders and more specific on their association with SP and SR. In the first section, the different types of eating disorders will be defined and their prevalence and consequences will be described with a focus on the period of adolescence. Next, a theoretical frame will be provided to integrate the most important etiological factors of eating disorders. Among these are the previously mentioned traits SP and SR. In the second section, these traits will be defined within the theoretical framework of the Reinforcement Sensitivity Theory and their operationalization will be discussed. In the third section, the nature of the association between eating disorders and the traits SP and SR will be described. The shortcomings within the scientific literature regarding this topic will be discussed, leading to the five studies of this dissertation that will be addressed in the following chapters.

Eating Disorders

Definition

Eating Disorders are known as detrimental disorders with a high mortality rate (Carta, et al., 2014). They can be broadly defined as *"a persistent disturbance of eating behaviour or behaviour intended to control weight, which significantly impairs physical health or psychosocial functioning. This disturbance should not be secondary to any recognized general medical disorder (e.g. a hypothalamic tumor) or any other psychiatric disorder (e.g. anxiety disorder)"(Fairburn & Walsh, 2002, p. 171)*.

According to the Diagnostic and Statistical Manual of Mental Disorders 5th edition (DSM-5; APA 2013) four types of adult eating disorders are discriminated, namely Anorexia Nervosa (AN), Bulimia Nervosa (BN), Binge Eating Disorder (BED) and Other Specified Feeding or Eating Disorder (OSFED). AN is characterized by restrictive eating, fear of gaining weight while having underweight and a disturbed body perception. Two AN subtypes are discriminated: AN of the Restrictive type (AN-R), which is diagnosed when the weight loss is caused by restrictive eating without binge/purge behaviour, and AN of the Binge/Purge type (AN-B/P), which is diagnosed when restrictive eating is combined with binge/purge behaviour. BN is characterized by recurrent episodes of binge eating (eating a large amount of food in a short time period and experiencing loss of control over this food intake), recurrent inappropriate compensatory behaviour to avoid weight gain, and a self-evaluation that is largely dependent on body shape and weight. Similar to BN, BED is also characterized by recurrent episodes of binge eating, but BED patients do not perform any compensatory behaviour. OSFED applies to individuals who show eating disorder symptoms without answering completely to the full diagnostic criteria for AN, BN or BED.

It is important to note that the DSM-5 criteria have been introduced only recently, and as such many relatively recent studies are still based on the DSM-IV criteria (APA, 2000), which is also the case for the studies in the present dissertation. However, this should have little influence on the results, when looking at the differences between the DSM-IV and the DSM-5 criteria. More specifically, the most important difference is the addition of BED as a separate eating disorder in the DSM-5, while in the DSM-IV, BED was defined as one of the Eating Disorders Not Otherwise Specified (EDNOS) or OSFED in the DSM-5. However, since BED was already recognised as an unspecified eating disorder in the DSM-IV (APA, 2000), BED patients were already diagnosed as such in the present clinical samples before this diagnosis was officially included as a separate category. A second important difference is the absence of the criterion of amenorrhea for AN in the DSM-5. However, this criterion has not been applied to diagnose the patients included in the present samples, since this criterion has proven to be a non-reliable one (APA, 2013). A third important change is that the number of binge eating episodes one has to report over a week to meet the criterion of ‘binge eating’ has been reduced from twice a week during at least three months in the DSM-IV to once a week during at least three months in the DSM-5. This means that the criteria used in the present studies were stricter. This may have resulted in samples with patients who have more severe eating disorders compared to samples that are recruited based on the DSM-5, which might limit the generalizability of the findings to more severe clinical samples. However, course and outcome studies on AN and BN show no significant differences between DSM-IV and DSM-5 based diagnoses (Smink, van Hoeken, & Hoek, 2013).

Prevalence and Consequences

Eating disorders appear to be fairly common. In adult samples including both female and male participants, prevalence rates of 0.7% for AN, 0.6% for BN and 0.5% for BED are reported, based on the DSM-IV criteria (APA 2000), with eating disorders being more frequently present among females than among males (Carta, et al., 2014). When looking at the lifetime prevalence for DSM-5 based criteria among females, eating disorders are reported with prevalence rates of 4%, 2% and 2% for AN, BN and BED respectively (Smink et al., 2013).

Adolescence appears to be a specific vulnerable period for the development of an eating disorder, especially in females. Based on the DSM-5 criteria, prevalence rates of 1.7% for AN, 0.8% for BN and 2.3% for BED were found in a cohort of Dutch female adolescents, that was followed from the age of 11 years until the age of 19 years (Smink, van Hoeken, Oldehinkel, & Hoek, 2014). Incidence rates for AN were found to be highest in female adolescents between 15 and 19 years old, whereas the highest incidence rates for BN were found in 20 to 24 year old females (Hoek & Van Hoeken, 2013). These numbers are alarming, given that eating disorders or eating disorder symptoms developed during childhood and adolescence often remain stable (Kotler, Cohen, Davies, Pine, & Walsh, 2001), with reports of symptoms persisting during a period of 5 years (Tanofsky-Kraff, et al., 2011). Moreover, the early development of eating disorder symptoms, such as binge eating, is found to be predictive for the development of a full-blown eating disorder later in life (Tanofsky-Kraff et al., 2011). Taking into account the detrimental impact on both physical and psychological well-being of eating disorder patients, these findings become even more alarming. More specifically, the impact of eating disorders on quality of life has been found to be comparable to that of severe and chronic psychiatric and general medical conditions (Carta et al., 2014). Moreover, both AN and BN are associated with increased mortality (Smink et al., 2013) and recovery rates vary between 52% and 69.1% for AN and between 50% and 55% for BN (Smink et al., 2013).

These findings illustrate why eating disorders are considered an important public health problem (Carta et al., 2014) and show the importance of gaining more insight into underlying mechanisms, especially in adolescents. As such, many studies have already been conducted to understand the aetiology of eating disorders. In the following paragraph, several of the (assumed) etiological factors will be discussed.

Aetiology

Considering the aetiology of eating disorders, several risk factors have emerged that are situated at three levels: the biological level, the intrapersonal/psychological level and the interpersonal level. More specifically, at (a) the biological level, a disruption of neurotransmitter systems has been examined as risk factor for eating disorders (Kaye, Wierenga, Bailer, Simmons, & Bischoff-Grethe, 2013; Steiger & Bruce, 2007), at (b) the intrapersonal/psychological level, some of the most important risk factors seem to be body dissatisfaction and perfectionism (Fairburn, Cooper, & Shafran, 2003; Pamies & Quiles, 2014) and at (c) the interpersonal level, for example social pressure (Francisco, Narciso, & Alarcao, 2013) and being the victim of bullying (Duarte, Pinto-Gouveia, & Rodrigues, 2015) have been associated with an increased risk to develop an eating disorder.

According to diathesis-stress models of eating disorders, it is especially the interplay of these different risk factors that leads to the actual development of an eating disorder (Hankin & Abela, 2005; Munro, Randell, & Lawrie, 2016). For example, it has been found that individuals with an avoidant coping style have an increased risk to develop an eating disorder, and this risk is especially heightened when they also experience a high level of daily stress (MacNeil, Esposito-Smythers, Mehlenbeck, & Weismoore, 2012). Based on relatively recent vulnerability models of psychopathology, the probability of developing a mental disorder, such as an eating disorder, is increased by the interaction between reactive temperament traits (bottom-up processes) and regulative traits (top-down processes) (Lonigan, Vasey, Phillips, & Hazen, 2004; Nigg, 2006; Nigg, Silk, Stavro, & Miller, 2005).

With regard to the domain of eating disorders, the temperament traits Sensitivity to Punishment (SP) and Sensitivity to Reward (SR) are often considered as a part of this diathesis or as reactive temperament traits increasing the vulnerability to develop an eating disorder (e.g. Harrison, O'Brien, Lopez, & Treasure, 2010), since altered levels of these traits are thought to increase the probability of developing eating disorders in general or specific eating disorder subtypes (Harrison et al., 2010).

In the following paragraphs, the traits SP and SR will be situated within the Reinforcement Sensitivity Theory and their association with eating disorders will be discussed. The focus on these specific traits as potential vulnerability factors is based on the fact that they are the reflection of relatively basic, core biological systems (Gray, 1970, 1982, 1987; Gray & McNaughton, 2000), which will be discussed in more detail below. As such these traits can be seen early in life. Recent research that focused on these traits has led to preliminary findings that support the assumed importance of these traits in eating disorders (e.g. Harrison et al., 2010; Glashouwer, Bloot, Veenstra, Franken, & De Jong, 2014).

Sensitivity to Punishment and Reward

Sensitivity to Punishment, Sensitivity to Reward and the Reinforcement Sensitivity Theory

Original Reinforcement Sensitivity Theory. The RST is a sociobiological model of motivational behaviour, closely linked to models of temperament and as such often used in personality research (e.g. Harrison et al., 2010). According to the original RST (Gray, 1982, 1987), there are three biological systems governing appetitive, aversive and emotional behaviour, namely the Behavioural Activation System (BAS), the Behavioural Inhibition System (BIS) and the Fight-Flight-System (FFS) respectively (Gray, 1970, 1982, 1987). In this first model, the BAS is thought to be activated in response to conditioned appealing stimuli (reward and non-punishment) and to lead to approach or goal-directed behaviour. The BIS on the other hand is thought to respond to signals of punishment, frustrating non-reward and novelty. It is thought to inhibit ongoing behaviour and to increase arousal and attention to environmental stimuli. The third and last motivational biological system, the FFS, is assumed to respond to the presence of unconditioned aversive stimuli and to lead to defensive aggression (fight) or escape behaviour (flight) (Gray, 1970, 1982, 1987). Situational factors are a key determinant of the output of this system: flight is assumed to result from distal threats or threats that can be escaped from, if not, fight is assumed to result. This means that, as noted by Smillie, Pickering and Jackson (2006), the distinction between the FFS and the BIS is quite vague in the first RST, as they can both be considered as punishment systems with very similar roles.

Revised Reinforcement Sensitivity Theory. In 2000, the RST was revised and several modifications were made (Gray & McNaughton, 2000). One of the most important changes was the disappearance of the distinction between conditioned and unconditioned stimuli. As such the BAS is now assumed to mediate responses to all appetitive stimuli, both conditioned and unconditioned, and the FFS, now called the Fight Flight Freeze System (FFFS), is assumed to respond to all aversive stimuli (Gray & McNaughton, 2000). This implies that also the function of the BIS is seen differently. The revised RST posits that the BIS inhibits all ongoing behaviour, regardless of its appetitive or aversive nature, whenever conflicts arise due to competing motivational objectives. The competing motivational objectives thought to activate the BIS could be approach-approach, avoidance-avoidance or approach-avoidance in nature (Gray & McNaughton, 2000). Whenever such a situation occurs, the BIS inhibits ongoing behaviour to allow the individual to choose the optimal behaviour (Bijttebier, Beck, Claes, & Vandereycken, 2009) by either engaging the BAS, leading to approach behaviour, or engaging the FFFS, leading to fight, flight or freeze responses. Which system is activated is assumed to be based on the value of the received reinforcing signals. As such, the BIS becomes a system for conflict detection and resolution (Smillie et al., 2006).

Neurobiological Structures. As previously mentioned, the RST is a sociobiological model in the sense that the proposed systems have a neurobiological basis. More specifically, the BAS is related to dopaminergic pathways such as the ventral tegmental area and the nucleus accumbens of the ventral striatum (Brenner, Beauchaine, & Sylvers, 2005). The BIS is related to a network of neural structures, as it governs behaviour in response to conflicts between competing goals. More specifically, the amygdala and the septo-hippocampal system play a role in BIS-governed behaviour (Brenner et al., 2005; Hahn, et al., 2010). Brain areas related to the FFFS involve a neural network including the periaqueductal gray, the medial hypothalamus and the amygdala (Gray & McNaughton, 2000; McNaughton & Corr, 2004).

Sensitivity to Punishment and Reward. SP and SR are related to the RST in the sense that they are seen as two traits reflecting the sensitivity of the three biological RST-systems. This is most clear for SR, which is defined as the proneness to detect signals of reward in the environment and to experience positive affect in rewarding situations (Davis & Fox, 2008). More specifically, SR is seen as the reflection of interindividual differences in the sensitivity of the BAS (Davis & Fox, 2008; Harrison, et al., 2010) because a strongly reactive approach system (sensitive BAS) is supposed to be highly sensitive to reward or to cues that signal reward (Gray, 1993). SP on the other hand is defined as the proneness to detect signals of punishment in the environment and to experience negative affect in punishing situations (Davis & Fox, 2008) and is less clearly associated with only one of the RST-systems. More specifically, SP is seen by some as a dispositional trait related to BIS-sensitivity (Harrison, et al., 2010; Harrison, Treasure & Smillie, 2011), whereas others claim that, according to the revised RST, SP is not a feature of the BIS but of the FFFS, as the FFFS is activated in the presence of signals of punishment (Brenner et al., 2005; Smillie et al., 2006). Throughout the following studies of the present dissertation, SP will be defined as a trait-reflection of the combined sensitivity of the revised BIS and the revised FFFS. A first argument for this proposition is that, although the FFFS is defined as a pure punishment system, the BIS is activated by conflict, which can be seen as a negative event or punishment as well. Moreover, the distinction between the BIS and the FFFS appears to be very hard to make using self-report questionnaires (Smillie et al., 2006) and therefore, it seems reasonable to assume that the more broader concept of SP reflects both BIS- and FFFS- sensitivity, as noted before by Harrison et al. (2010).

Operationalization of Sensitivity to Punishment and Reward

Both SP and SR are operationalized in divergent ways. First, there are different levels on which SP and SR are measured, namely through self-report, on a neurobiological level, and on a behavioural level. Second, different specific instruments are used within these levels to operationalize SP and SR. The majority of studies on SP, SR and eating disorder symptoms have been based on three different self-report questionnaires (e.g. Harrison et al., 2010; Glashouwer et al., 2014) that will be discussed next, followed by a brief description of neurobiological and behavioural measures.

BIS/BAS Scales. One of the most widely used self-report questionnaires regarding SP and SR is the BIS/BAS Scales (Carver & White, 1994). The BIS/BAS Scales are based on the original RST and consist of one BIS and three BAS-subscales, namely BAS-Drive (the persistent pursuit of desired goals), BAS-Fun Seeking (the desire for new rewards and a willingness to approach potentially rewarding events) and BAS-Reward Responsiveness (positive responses to reward) (Carver & White, 1994). As the BIS/BAS Scales (Carver & White, 1994) are based on the original RST, the BIS-subscale contains items referring to both the revised BIS and the revised FFFS (Smillie et al., 2006).

Besides the fact that the BIS/BAS Scales are based on the original RST, this questionnaire shows some additional shortcomings, such as the fact that the subdivision of the BAS-scale into three components is not clearly justified by the authors (Carver & White, 1994; Torrubia, Avila, Molto & Caseras, 2001) as well as the fact that the items of the BIS/BAS Scales are related to generalized SP and SR, whereas theoretically the RST deals with specific cues of punishment and reward (Matthews & Gilliland, 1999; Torrubia, et al., 2001).

Sensitivity to Punishment and Sensitivity to Reward Questionnaire. The Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ; Torrubia, et al., 2001) is a more recently developed questionnaire that is also based on the RST and that takes several of the shortcomings of the BIS/BAS Scales into account. For example, in line with RST, the SPSRQ consists of one scale to measure SP and one to measure SR, without further subdivisions. Furthermore, the items of the SPSRQ are related to specific punishments and rewards. Nevertheless, similar to the BIS/BAS Scales, the SPSRQ has the limitation that it was based on the original and not the revised

RST. Again, this means that the SP-subscale includes items measuring both BIS- and FFFS-sensitivity as defined by the revised RST (Gray & McNaughton, 2000).

Temperament and Character Inventory. A third questionnaire that is often used to operationalize SP and SR is the Temperament and Character Inventory (TCI; Cloninger, Svrakic, & Przybeck, 1993) (e.g. Harrison et al; 2010). This questionnaire is based on Cloninger's model of personality (Cloninger, 1987; Cloninger et al., 1993), which is theoretically related to the RST. Cloninger's model of personality posits that personality comprises four innate temperament dimensions and four acquired character dimensions. Among these are two major temperament dimensions that are associated with SP and SR. These are Harm Avoidance (HA), defined as the tendency of inhibiting responses in the face of aversive stimuli, leading to the avoidance of punishment and non-reward, and Novelty Seeking (NS), defined as the tendency to respond actively to novel stimuli, leading to reward or escape from punishment. HA and NS are considered responsible for inhibition and activation of behaviour respectively and have a neurobiological basis closely related to that of the BIS and the BAS respectively (e.g. Gerra, Zaimovic, Timpano, Zambelli, Delsignore, & Brambilla, 2000; Hansenne & Ansseau, 1999; Hansenne, Pinto, Pitchot, Reggers, Scantamburlo, Moor, & Ansseau, 2002). As such, HA and NS are associated with SP and SR respectively (Mardaga & Hansenne, 2007) and are often used interchangeably (e.g. Harrison et al., 2010). However, it is important to note that these traits cannot be seen as interchangeable, especially in the case of SR and NS. More specifically, according to Dawe and Loxton (2004) SR and NS are two different components of a broader concept with the BAS as the biological basis. SR is thereby thought to reflect a heightened sensitivity to unconditioned and conditioned cues of reward, whereas novelty seeking more typically refers to behaviours that are rash and spontaneous (Dawe & Loxton, 2004; Dawe, Gullo & Loxton, 2004). However, like the BIS/BAS Scales and the SPSRQ, the TCI is often used in research on the association between SP, SR and eating disorder symptoms (e.g. Atiye et al., 2015; Cassin & Von Ranson, 2005; Glashouwer et al., 2014; Harrison et al., 2010).

Neurobiological and behavioural measures. In neurobiological research, fMRI designs and PET-scans have been used to measure (dysfunctional) reward responses (Via et al., 2015) and dopamine availability when confronted with food stimuli (Beaver, Lawrence, van Ditzhuijzen, Davis, Woods, & Calder, 2006; Volkow et al., 2003;). Several behavioural measures have been reported as well, such as a verbal operant conditioning task (Farmer et al., 2001) and a card sorting task (Loxton and Dawe, 2007) to measure SR and a spatial orientation task (Derryberry & Reed, 1994) to measure both SP and SR.

Although neurobiological research is necessary to amplify our knowledge on the role of SP and SR in eating disorders, this was beyond the scope of the present dissertation. As will be discussed below, most studies of this dissertation were based on one or more of the previously described self-report questionnaires, because this allowed obtaining larger samples and facilitated the integration with previous studies. However, because the use of self-report questionnaires has several limitations, a behavioural measure of SR and SP, namely a spatial orientation task (Derryberry and Reed, 1994) was used in one study as well. A more detailed description of this instrument can be found in Chapter 3.

The Role of Sensitivity to Punishment and Sensitivity to Reward in Eating Disorders

Eating behaviour is governed by three separate but integrated brain functions: homeostatic regulation of the energy balance, emotional-based motivation for eating and cognitive regulation of food intake (Bruce, Martin,

& Savage, 2011; Shin, Zheng, & Berthoud, 2009). As such, the BIS, the BAS and the FFFS and the associated traits of SP and SR are assumed to play a role in eating behaviour, as they govern human motivational behaviour. The extreme avoidance and approach tendencies regarding food that are characteristic of eating disorders, lead to the assumption that altered sensitivity levels of the BIS, BAS and FFFS may be present in patients with an eating disorder, causing these extreme tendencies. This means that individuals with altered levels of SP and SR may be more vulnerable to develop an eating disorder. In the following paragraph, the most important findings in this area so far will be discussed.

Empirical Findings so far

General Hypothesis. The general hypothesis regarding the role of SP and SR in eating behaviour holds that SP is transdiagnostically increased whereas the level of SR shows interdiagnostic differences (e.g. Harrison et al., 2010). This is explained by the theoretical proposition that individuals with high SP (i.e. sensitive BIS/FFFS) will show more avoidant behaviour towards food and will experience more feelings of anxiety, which seems to be the case for all eating disorder types. Likewise, individuals with high SR (i.e. sensitive BAS) are assumed to show more approach behaviour towards food and will show more impulsive behaviour, which seems to be the case for eating disorder subtypes that are characterized by binge/purge behaviour. The underlying assumption in most studies is that these expected alterations in SP and SR are present before the onset of the eating disorder and function as risk and maintaining factors (Atiye, Miettunen, & Raevuori-Helkamaa, 2015; Bloks, Hoek, Callewaert, & Van Furth, 2004; Cassin & Von Ranson, 2005; Glashouwer et al., 2014; Harrison et al., 2010; Rowe, Jordan, McIntosh, Carter, Frampton, Bulik, & Joyce, 2011; Segura-Garcia, Chiodo, Sinopoli, & De Fazio, 2013). This is in line with diathesis-stress models positing that temperament can function as a diathesis (Hankin & Abela, 2005; Munro, et al., 2016). Below, several cross-sectional clinical and community studies on the role of SP and SR in eating disorders will be discussed as well as some prospective studies.

Cross-sectional Clinical Studies. Most research so far has tested the level of SP and SR on a cross-sectional basis in clinical samples using self-report questionnaires. In these studies, the general finding is that SP and the related trait HA are transdiagnostically increased. SR and the related trait NS are often found to be decreased in AN-R patients and increased in AN-B/P and BN patients compared to healthy controls (Atiye, et al., 2015; Cassin & Von Ranson, 2005; Harrison et al., 2010). However, although these findings are consistent with the hypothesis that SP and SR function as risk and maintaining factors, no causal conclusions can be drawn from these studies. Moreover, a high degree of inconsistency has been reported. Especially the level of SR in AN-R seems unclear, with some authors reporting increased instead of decreased levels of SR in AN-R patients (e.g. Glashouwer et al., 2014; Jappe et al., 2011).

Cross-sectional Non-Clinical Studies. Studies regarding the association between SP, SR and eating behaviour in non-clinical samples are relatively scarce. However, one study in a convenience sample of university students has shown heightened SP and SR to be associated with dysfunctional eating patterns characterized by drive for thinness and binge eating (Loxton & Dawe, 2006). In adolescent samples, it was found that dysfunctional eating characterized by binge eating was associated with both increased SP and increased SR (Loxton & Dawe, 2001). In a non-clinical female adolescent sample, Walther and Hilbert (2016) found SR, but not SP, to be positively associated with restrained eating. Neurobiological research in healthy subjects also provides evidence for a positive association between SR and brain activity in response to appetizing food cues (Beaver, et al. 2006). Taken together, the limited findings in community samples are similar to the results in clinical samples: increased SP and SR seem to be associated with disordered eating behaviour before the onset of full-blown eating disorders. However, it should be noted that these studies are not only few in number, but also reveal some inconsistent results.

Prospective Studies. As mentioned above, to gain more insight into the causal and/or maintaining role of SP and SR, prospective research is necessary. Although limited in number, some longitudinal studies have been conducted in clinical samples: one study examined the predictive role of SP and SR for weight gain in AN-R and AN-B/P patients over one year, but found no significant results (Glashouwer et al., 2014). Three other studies based on Cloninger's model of personality reported mixed evidence: two studies found no evidence that temperament might predict symptom change (Bloks, et al., 2004; Rowe et al., 2011) whereas, according to a third study, the traits HA and NS are predictive for symptom change (Segura-Garcia, et al., 2013). This inconsistent evidence implies that, so far, no clear conclusions can be drawn regarding the influence of SP and SR on the course of eating disorders.

Research Gaps

Based on the previously discussed studies, there is evidence that the level of SP and SR is altered in patients with an eating disorder and associations have been found between SP, SR and eating behaviour in non-clinical samples. However, several unresolved issues remain.

First, although a main assumption is that SP and SR function as risk factors, research has mostly been conducted in clinical samples. Little research has been done regarding the role of SP and SR in non-clinical samples as risk, such as adolescents. As such, it is difficult to draw conclusions regarding the role of SP and SR in eating behaviour before the onset of an eating disorder. An additional methodological issue is that the validity of the BIS/BAS Scales (Carver & White, 1994) and the SPSRQ (Torrubia et al., 2001) in (Flemish) adolescents is unclear, which further complicates research regarding the role of SP and SR in adolescent's eating behaviour.

A related second gap is that most research in clinical samples is cross-sectional in nature. This is an important shortcoming, since another main assumption is that SP and SR may influence the course of an eating disorder. Until now, only few studies have examined on a prospective basis whereas arguments can be found for this maintaining role of SP and SR in eating disorders.

Third, different questionnaires have been used over different studies to operationalize SP and SR, although these instruments might not tap the same concepts. Especially regarding SR, there are differences between the BAS-scale (Carver & White, 1994), the SR-scale (Torrubia et al., 2001) and NS (Cloninger et al., 1993). More specifically, as described earlier in the introduction, the BAS-scale is divided into three subscales and measures the sensitivity for general rewards (Carver & White, 1994), the SR-scale is focused on specific rewards (Torrubia et al., 2001) and the NS-scale measures a related, but different aspect of the BAS than SR (Cloninger et al., 1993). It is possible that these different approaches lead to different results and may as such, at least partly, explain the inconsistent findings regarding SR.

Fourth, patients with AN-R and AN-B/P are often included as one diagnostic category (Harrison et al., 2010), while it is possible that temperamental differences exist between these subtypes. More specifically, if SR is associated with binge/purge behaviour, a higher level of this trait is expected in patients with AN-B/P compared to patients with AN-R. As such, mixed results regarding the level of SR can be found when taking these diagnostic subtypes together.

Fifth, most research is based on self-report questionnaires of SP and SR, while it is not clear whether these questionnaires fully tap the concept of SP and SR. The main issue with these self-reports is that especially the intensity of negative or positive affect in punishing or rewarding situations is measured or the tendency to avoid or approach certain situations. However, the sensitivity for detecting cues predicting punishment or reward cannot be measured through self-report, although it is an important aspect of SP and SR (Davis & Fox, 2008).

A sixth gap is the lack of research regarding interactions between different temperament traits to better understand how SP and SR may influence disordered eating behaviour. The aim of the majority of studies in this domain is to examine whether the levels of these traits are altered in specific diagnostic subtypes and to test whether they are associated with certain eating disorder symptoms. The study of Glashouwer et al. (2014) is one of the few studies including the interaction between SP and SR to explain symptom evolution in patients with an eating disorder. It seems important to investigate this interaction more frequently given the assumption that the BIS and the BAS are only activated independently from each other in extreme situations containing only appetitive or aversive stimuli (Corr, 2002). It is suggested that in many situations the different systems are activated simultaneously because mixed signals of punishment and reward are present. The behavioural outcome depends then on the relative strength of one system compared to the other (Corr, 2002). As such, it seems important to investigate the interaction of SP and SR in influencing eating behaviour and to focus more on temperamental profiles instead of separate traits.

In addition, there is also a lack of studies including regulative traits that may buffer the effect of SP and SR. As previously mentioned when discussing the aetiology of eating disorders, vulnerability models of psychopathology suggest that it is the interplay between reactive traits (such as SP and SR) and regulative traits that is important in the development of mental disorders (Lonigan, Vasey, Phillips, & Hazen, 2004; Nigg, 2006; Nigg, Silk, Stavro, & Miller, 2005). From this perspective, effortful control, or the ability to voluntary focus and shift attention and to voluntary activate or inhibit behaviour (Rothbart, 1989; Rothbart & Ahadi, 1994), is an important regulative character trait that is assumed to function as a potential protective factor in the presence of a vulnerable reactive temperament profile (Bijttebier, et al., 2009). As such, gaining more insight into the assumed interaction between SP, SR and effortful control is necessary to increase our understanding of the role of SP and SR in eating disorders. Moreover, this might also lead to important clinical insights for prevention and therapeutic strategies. More specifically, effortful control is assumed to have a high level of plasticity (Berkman, Graham, & Fisher, 2012), leading to the hypothesis that the training of effortful control could be an important preventive or therapeutic strategy if this trait functions as a protective factor.

In this respect, it is important to note that also the trait persistence, stemming from Cloninger's model of personality, is altered in patients with an eating disorder (Atiye et al., 2015). More specifically, persistence refers to the level of perseverance despite frustration and fatigue (Cloninger et al., 1993) and, as such, seems to show some theoretical overlap with the concept of effortful control. Therefore, taking this trait into account, while examining the effect of SP and SR on eating behaviour, could be important as well.

In conclusion, these limitations emphasize the necessity to conduct more research regarding the association between SP, SR and disordered eating behaviour in both clinical and non-clinical samples. The different gaps that were highlighted above have led to four main study objectives for the present dissertation, which resulted in six separate studies. These study objectives will be discussed next.

Study Objectives

1. Do Patients with an Eating Disorder show Similar Transdiagnostic and Interdiagnostic Differences in SP and SR Based on Different Instruments? As discussed above**,** research regarding SP and SR in the domain of eating disorders struggles with several methodological limitations. The use of different questionnaires in different studies and the lack of measures of SP and SR other than self-reports could in part explain the inconsistent findings, especially regarding SR.

As such, it was the aim of the present dissertation to gain more insight into instrument-specific findings regarding the level of SP and SR in patients with an eating disorder by replicating previous findings on this topic, thereby using different instruments. To obtain this objective, two studies were conducted. In study 1, the level of SP and SR was examined in patients with different eating disorder subtypes and a control sample using three different self-report questionnaires. Patients with AN-R and AN-B/P were included as separate categories, consistent with the above mentioned concerns regarding this topic. In study 2, a performance based measure of SP and SR was used, measuring attentional bias for cues predicting punishment and reward. The level of these attentional biases was compared in patients with a restrictive eating disorder, being AN-R, in patients with an eating disorder characterized by binge/purge symptoms, being AN-B/P and BN, and in a control group.

2. Can we Find Arguments for the Hypothesis that SP and SR may Function as Risk Factors? As previously mentioned, the general assumption is that altered levels of SP and SR precede the development of an eating disorder and function as (causal) risk factors (e.g. Atiye et al., 2015; Cassin & Von Ranson, 2005; Harrison et al., 2010). This implies that, ideally, longitudinal research in community samples should be conducted to examine whether SP and SR are already altered before the onset of an eating disorder and predict its development. In the present dissertation it was examined whether specific temperament profiles based on SP and SR were associated with disordered eating behaviour in a community sample (study 3). It was chosen to focus on non-clinical adolescents, because they are regarded as a group at risk (Smink, et al, 2014) and to include multiple instruments measuring SP and SR. In doing so, it was the aim to investigate whether arguments could be found for the hypothesis that SP and SR are risk factors. Altered levels of SP and SR should be found before the onset of a full-blown eating disorder and they should be associated with disordered eating behaviour if these traits indeed increase the vulnerability to develop an eating disorder.

3. Can we Find Arguments for a Maintaining Role of SP and SR in Eating Disorders? Beside the general assumption that SP and SR function as risk factors for the development of an eating disorder, it is also assumed that SP and SR influence the course of an eating disorder (e.g. Bloks, et al., 2004; Glashouwer et al., 2014; Rowe et al., 2011; Segura-Garcia, et al., 2013). However, the few studies on this hypothesis report mixed findings (Bloks, et al., 2004; Glashouwer et al., 2014; Rowe et al., 2011; Segura-Garcia, et al., 2013). As such, one of the objectives of the present dissertation was to examine whether arguments could be found for a maintaining role of SP and SR in eating disorders. This led to a clinical follow-up study examining the predictive value of SP and SR for short term symptom evolution in patients with an eating disorder (study 4). Again, different questionnaires were used to measure SP and SR. In addition, not only the main effects of SP and SR were examined, but also their interaction. The trait persistence was also included as a predictor to gain more insight into its possible moderating effect. The reason for examining these interactions will be further elaborated upon when discussing the following study objective.

4. Do we Have to Acknowledge Other Temperament Factors? It is not clear yet whether SP and SR interact with each other and/or with other temperament traits in influencing disordered eating behaviour. Gaining more insight into these topics might be important since it could give more insight into how SP and SR may be involved in eating disorders and since it could help to explain the inconsistent findings regarding SR. As such, the final objective of the present dissertation was to examine whether arguments could be found for an interaction between SP, SR and other traits in influencing eating behaviour. This led to two separate studies. First, in the clinical follow-up study described above (study 4) not only the predictive value of SP and SR was examined, but also the predictive value of their interaction and of the interaction with persistence. In addition, a study was conducted in an adolescent community sample to examine the moderating role of effortful control in the association between SP, SR and eating behaviour (study 5).

The five different studies that resulted from these research objectives will be discussed in separate chapters, followed by a concluding chapter in which the different findings will be discussed. An overview of these chapters will be provided below.

Overview of Chapters

Chapter 2: Temperamental Differences between Adolescents and Young Adults with or without an Eating Disorder.

The goal of the first study (Matton, Goossens, Vervaet, & Braet, 2015) was to replicate previous cross-sectional research comparing the level of SP and SR between patients with different eating disorder diagnoses and a control sample. Given the previous inconsistent findings regarding the level of SR in different eating disorder diagnoses (e.g. Harrison et al., 2010) and the use of divergent self-report questionnaires to measure SP and SR throughout studies, multiple instruments to measure SP and SR were used. Moreover, patients with AN-R and with AN-B/P were examined as separate categories because different levels of SR could be expected for these diagnoses. By conducting this study, it was not only tested whether the general hypothesis regarding altered levels of SP and SR in eating disorders could be replicated in Flemish patients, but also whether the high degree of inconsistency regarding the level of SR would be partly explainable by the use of different measures in different studies and by the inclusion of patients with AN-R and AN-B/P into one category.

Chapter 3: Sensitivity for Cues Predicting Reward and Punishment in Young Women with Eating Disorders.

The second study (Matton, de Jong, Goossens, Jonker, Vervaet, De Schryver, & Braet, *under review*) was set up as a pilot study that departed from the finding that most studies use self-report questionnaires to measure SP and SR, while these seem incapable to measure the sensitivity for cues predicting punishment and reward. More specifically, self-report questionnaires generally measure the negative or positive affect in response to actual punishment or reward respectively, but not the sensitivity for cues predicting punishment or reward. As such, in this pilot study a Spatial Orientation Task (Derryberry & Reed, 1994) was used to measure and compare the sensitivity for cues predicting punishment or reward in patients with an eating disorder and a a control group. These results may help to understand to inconsistent findings on SR. Moreover, by studying attentional bias towards punishment or reward, these results could give more insight into how SP and SR may influence eating behaviour.

Chapter 4: Punishment and Reward Sensitivity: Are Naturally Occurring Clusters in these Traits Related to Eating and Weight Problems in Adolescents?

The study described in this chapter (Matton, Goossens, Braet, & Vervaet, 2013) was based on the general assumption that SP and SR function as risk factors, preceding the development of an eating disorder (Atiye et al., 2015; Cassin & Von Ranson, 2005; Harrison et al., 2010). As such, the focus was on adolescents, because they show an increased vulnerability to develop eating disorders (Smink et al., 2014). In addition, the study departed from the assumption that temperamental profiles may be important to consider, in addition to the influence of separate traits (Corr, 2002).

As such, the first aim was to examine whether the four theoretically expected temperamental profiles based on SP and SR could be found in a community sample of adolescents. The second aim was to examine whether specific eating styles and eating disorder symptoms are increased in specific profiles. Both the SPSRQ (Torrubia et al., 2001) and the BIS/BAS Scales (Carver & White, 1994) were used to operationalize SP and SR.

Chapter 5: The role of Temperament in Short-Term Symptom Evolution in Patients with an Eating Disorder.

It is assumed that SP and SR may play a maintaining role in eating disorders (Bloks, et al., 2004; Glashouwer et al., 2014; Rowe et al., 2011; Segura-Garcia, et al., 2013). However, the cross-sectional research that has been performed so far does not allow drawing any conclusions regarding this maintaining role of SP and SR (Harrison et al., 2010). Moreover, few studies investigate the interaction between SP, SR and other traits found to be altered in patients with an eating disorder, such as persistence. Therefore, our aim was to increase our insight into the maintaining role of SP, SR, and their interaction in eating disorder symptoms as well as to investigate the moderating role of persistence in these associations. As such, in this study, a sample of patients with an eating disorder was followed up six months after their intake at a Centre for Eating Disorders to examine the predictive effect of SP, SR, persistence and their interactions on short term symptom improvement or deterioration.

Chapter 6: Effortful Control as a Moderator in the Association between Punishment and Reward Sensitivity and Eating Styles in Adolescent Boys and Girls.

Recent theories of psychopathology (e.g. Bijttebier, Beck, Claes, & Vandereycken, 2009; Lonigan, Vasey, Phillips, & Hazen, 2004; Nigg, 2006) posit that the risk for the development of psychopathology depends on the interaction between reactive traits, such as SP and SR, and self-regulation abilities, such as Effortful Control (EC; Rothbart, 1989; Rothbart & Ahadi, 1994). However, little research has taken the interaction between these traits into account in the domain of eating disorders. Whereas the previous study focused on the interaction between several traits in a clinical sample, the present study focused again on an adolescent community sample, as adolescents are a group at risk. In this sample, the moderating role of effortful control was examined in the association between SP, SR and different eating styles. To operationalize effortful control, both a self-report questionnaire and a performance based measure were used (Matton, Goossens, Vervaet, & Braet, 2017).

Chapter 7: Discussion and Conclusions

In Chapter 7, the key findings of the different studies will be summarized and integrated and attention will be paid to the most important clinical implications and suggestions for future research. Both the strengths and the limitations of the described studies will be discussed as well. In the table below, an overview of the studies and their main characteristics can be found.

Table 1. Overview of the studies.

	sample characteristics	**design**	**operationalization of SP and SR**	**data analysis**
study 1: Temperamental Differences between Adolescents and Young Adults with or without an Eating Disorder.	n = 41 (AN-R) n = 20 (AN-B/P) n = 30 (BN) n = 292 (female control group) 14-25 years	cross-sectional	BIS/BAS Scales SPSRQ TCI – short form	(M)anova post-hoc Tukey test discriminant analysis
study 2: Sensitivity for Cues Predicting Reward and Punishment in Young Women with Eating Disorders.	n = 20 (AN-R) n = 16 (AN-B/P and BN) n = 23 (female control group) 14-29 years	cross-sectional	Spatial Orientation Task	(M)anova contrast calculation
study 3: Punishment and Reward Sensitivity: Are Naturally Occurring Clusters in these Traits Related to Eating and Weight Problems in Adolescents?	n = 579 14-19 years community sample 60.2 % female	cross-sectional	BIS/BAS Scales SPSRQ	cluster-analysis binary logistic and linear regression Mancova with post-hoc Tukey test
study 4: The role of Temperament in Short-Term Symptom Evolution in Patients with an Eating Disorder.	n = 42 (AN-R) n = 14 (AN-B/P) n = 39 (BN) n = 13 (BED) 14-54 years (overlapping with the sample from study 1)	follow-up	SPSRQ TCI	hierarchic linear regression with interaction terms
study 5: Effortful Control as a Moderator in the Association between Punishment and Reward Sensitivity and Eating Styles in Adolescent Boys and Girls.	n = 252 (54.0 % female) 14-19 years	cross-sectional	SPSRQ	hierarchic linear regression with interaction terms

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Chapter 2

Temperamental differences between adolescents and young adults with or without an eating disorder[1]

Abstract

There is an increasing interest into the role of temperament, and more specifically the traits Sensitivity to Punishment (SP) and Sensitivity to Reward (SR), in the occurrence of eating disorder (ED) symptoms. However, the results on this topic are inconsistent, different instruments are used to measure SP and SR and there is a lack of research on adolescents and young adults, although they form a group at risk to develop an ED. Therefore, the present objective was to study personality profiles co-occurring with specific EDs in adolescents and young adults.

The present study examined the levels of SP and SR for different ED-diagnoses, namely Anorexia Nervosa of the Restricting type (AN-R; n=41), Anorexia Nervosa of the Binge/Purge type (AN-B/P; n=20) and Bulimia Nervosa (BN; n=30), and compared these with a Healthy Control group (HC; n=292). SP and SR were measured by three different temperament questionnaires in order to rule out instrument-specific findings. Only female participants between the age of 14 and 25 years were included.

SP was transdiagnostically increased compared to HCs, whereas SR was lower in AN-R patients compared to BN patients. These results were independent of the questionnaire being used.

[1] Matton, A., Goossens, L., Vervaet, M., & Braet, C. (2015). Temperamental Differences between Adolescents and Young Adults with or without an Eating Disorder. *Comprehensive Psychiatry*, *56*, 229-238. doi: 10.1016/j.comppsych.2014.09.005

Further research is necessary to explain how these traits may influence specific ED-symptoms.

Introduction

Eating disorders (EDs) are detrimental conditions that often develop during adolescence and have negative consequences on a variety of psychosocial and physical domains in adult life (Brunner & Resch, 2006). Although several studies have been conducted to examine risk and maintaining factors for EDs (e.g. Fairburn, Cooper, & Shafran, 2003), especially for Anorexia Nervosa of the Restricting Type (AN-R), Anorexia Nervosa of the Binge/Purge Type (AN-B/P) and Bulimia Nervosa (BN) (Diagnostic and Statistical Manual of Mental Disorders (4th edition, text rev. (DSM-IV-TR); American Psychiatric Association (APA), 2000), many questions regarding the aetiology of EDs are still unanswered. It remains unclear why some people can hardly resist the omnipresence of high caloric fast-food in western communities, while people with AN-R seem to have it easier resisting these types of food than eating them. Moreover, while AN and BN are seen as different behavioural outcomes of the same underlying process according to the Transdiagnostic Model of EDs (Fairburn, et al., 2003), the question remains why AN patients are able to maintain a highly restrictive eating pattern, while BN patients seem to be swinging back and forth between restriction and binges. In other words, the determinants of individual reactions to our food environment are not clear yet.

Part of the explanation might be found in interindividual differences in temperament. More specifically, it seems that ED-patients have different personality-profiles compared to healthy controls (HCs), with some traits being related to EDs in general and some to specific ED-diagnoses (Cassin & von Ranson, 2005; Harrison, O’Brien, Lopez, & Treasure, 2010; Vervaet, Audenaert, & van Heeringen, 2004). Most research in this area relies on two related personality theories, namely the Reinforcement Sensitivity Theory (RST; Gray, 1970, 1982, 1987; Gray & McNaughton, 2000) and Cloninger’s model of personality (Cloninger, Svrakic, & Przybeck, 1993).

In its original version, the RST postulates that behaviour is governed by three biological systems, namely the Behavioural Activation System (BAS), the Behavioural Inhibition System (BIS) and the Fight-Flight System (FFS). The BAS is activated in response to conditioned appealing stimuli and leads to approach behaviour. The BIS responds to signals of punishment, frustrating non-reward and novelty and inhibits ongoing behaviour. The FFS responds to the presence of unconditioned aversive stimuli and leads to defensive aggression (fight) or escape behaviour (flight) (Gray, 1970, 1982, 1987). The traits Sensitivity to Punishment (SP) and Sensitivity to Reward (SR) are derived from this theory and refer to interindividual differences in the sensitivity of the BIS and the BAS respectively.

However, in 2000 the RST was revised (Gray & McNaughton, 2000) and several modifications were made. First, the distinction between conditioned and unconditioned stimuli disappeared and as such, the BAS is now assumed to be activated by both conditioned and unconditioned signals of reward. In the revised RST, the BIS no longer functions as a pure punishment system, but is conceptualized as a conflict detection and resolution system. It is activated by goal-conflict and leads to inhibition of behaviour. Concerning the FFS, the freeze-response was added and accordingly the name of this third system was changed into the Fight-Flight-Freeze System (FFFS). It is thought to be activated by signals of punishment and to lead to aggressive or escape behaviour.

These conceptual changes have implications for the way SP and SR are defined. More specifically, SR is still considered to reflect the sensitivity of the BAS, but the association between SP and the BIS seems to be replaced by an association between SP and the FFFS. However, the distinction between the BIS and the FFFS appears to be very hard to make using self-report questionnaires (Smillie, Pickering & Jackson, 2006). Moreover, both the conflict associated with the BIS as well as the pure punishment associated with the FFFS can be seen as forms of punishment. Therefore, it is assumed that the concept of SP reflects both BIS- and FFFS-sensitivity (e.g. Harrison et al., 2010; Matton, Goossens, Braet & Vervaet, 2013).

The second theory, Cloninger's model of personality (Cloninger, 1987; Cloninger et al., 1993), is based on the RST and contains four innate temperament dimensions and three acquired character dimensions. Especially the temperament dimensions Harm Avoidance (HA) and Novelty Seeking (NS) are important for the present objectives. More specifically, HA is defined as the tendency of inhibiting responses in the face of aversive stimuli, leading to the avoidance of punishment and non-reward. NS is defined as the tendency to respond actively to novel stimuli, leading to reward and escape from punishment. These two temperament dimensions form the two major dimensions responsible for behavioural inhibition and activation in this model and are as such theoretically related to the RST concepts (Cloninger, 1987). Therefore, associations between these traits and the traits SP and SR from the RST are often made (e.g. Harrison et al., 2010) and are empirically confirmed (Mardaga & Hansenne, 2007). Unfortunately, this also means that the concepts SP/HA and SR/NS are often used interchangeably (e.g. Harrison et al., 2010), which has added to the inconsistent operationalization of SP and SR as well as to the inconsistent findings regarding SP and SR in the ED-domain (e.g. Harrison et al., 2010). Therefore, questionnaires based on both models were used in the present study in order to test temperamental differences between EDs from the RST-perspective and from the perspective of Cloninger's model of personality.

As previously mentioned, an increasing amount of research focuses on the SP/HA and SR/NS dimensions to explain ED-symptoms within specific ED-diagnoses (e.g. Harrison et al., 2010). The rationale behind this is that people scoring high on SR will be more sensitive to food and thus show more binge eating compared to people scoring lower on SR (e.g. Loxton & Dawe, 2001). This implies that the level of SR might differ between ED-diagnoses (e.g. Harrison et al., 2010). On the other hand, for all ED-patients, eating seems to become punishing instead of rewarding from a cognitive and emotional point of view and patients suffering from AN-R seem to overcome the biological need to eat on top of that (Glashouwer, Bloot, Veenstra, Franken, & de Jong, 2014). This leads to the hypothesis that SP/HA is higher in all EDs compared to HCs, whereas SR/NS is hypothesized to be decreased in AN-R patients and to be increased in AN-B/P and BN patients (Harrison et al., 2010). These differences in temperament may explain why AN-R patients are able to maintain their restrictive eating pattern, namely by the combination of high SP/HA leading to inhibition and avoidance, and low SR/NS, hence less sensitivity for the rewarding effects of food. AN-B/P and BN-patients on the other hand show both the avoidance behaviour seen in AN-R, which probably resembles high SP/HA, but they also show binge/purge behaviour which might be explained by high SR/NS leading to more impulsive behaviour and to more sensitivity to the rewards of food as well (Glashouwer, et al., 2014).

In line with these hypotheses, a review of Harrison et al. (2010) showed that ED-patients scored higher on traits related to inhibition and avoidance than HCs, regardless of their specific ED-diagnosis, whereas traits related to approach behaviour discriminated between ED-diagnoses. More specifically, AN-R patients had lower scores on SR and NS compared to HCs, whereas AN-B/P and BN-patients showed higher scores on these traits. Another review from Cassin and von Ranson (2005) showed that all ED-patients scored higher on HA compared to HCs, while NS was lower in AN-R patients and higher in BN patients.

However, Harrison et al. (2010) found a high degree of inconsistency in the results, with several studies reporting opposite or insignificant findings. They argue that the inconsistent use of different measures of temperament as well as the lack of differentiation between AN-R and AN-B/P in several studies may contribute to the inconsistent evidence. Also the use of different age groups might add to the conflicting findings. More specifically, SR appears to be generally heightened during adolescence (Galvan, 2013). This means that differences found on this trait between ED-patients and HCs are not necessarily similar in adolescents or young adults as in adults. For example, a recent study on adolescents found increased instead of decreased SR in the AN-R group compared to HCs (Glashouwer et al., 2014).

However, it should be noted that the majority of studies on temperament and EDs has focused on adults, whereas few studies have included eating disordered adolescents and young adults (e.g. Harrison et al., 2010). Studying this specific age group might be important because of the previously mentioned increase in SR (Galvan, 2013). Especially since at the same time brain areas involved in inhibition are still underdeveloped (Galvan, 2013). A related second reason to focus on adolescence and young adulthood is that this period is characterized by heightened vulnerability to develop an ED (Hoek en Van Hoeken, 2003), especially in girls. Therefore it is important to examine this period to gain insight into the risk factors for developing an ED.

A better insight into the role of temperament in the development and maintenance of EDs might help us to understand the specific behaviour seen in different ED-diagnoses and might be helpful in screening for vulnerable individuals. Therefore, the objective of the present study was to examine the levels of SP, SR and the related temperament dimensions HA and NS in a clinical sample of female adolescents and young adults with AN-R, AN-B/P or BN and to compare these levels with those of HCs. Three different temperament questionnaires were used. As such, we wanted to rule out the possibility of finding instrument-specific results, especially since different results have been reported for different questionnaires (e.g. Glashouwer et al., 2014; Harrison et al., 2010).

It was hypothesized that SP/HA would be higher in all ED-patients compared to HCs. This hypothesis was based on the results of previous review studies (Cassin & von Ranson, 2005; Harrison et al., 2010) as well as on the theoretical assumption that human food intake is regulated by the (biological) rewarding effects of eating (e.g. Berridge, 1996, 2004), but that this may be impaired at the same time due to the emotional and cognitive punishment related to eating in EDs (Glashouwer et al., 2004). Regarding SR/NS, we expected a decrease in AN-R patients and an increase in AN-B/P and BN patients based on the theoretical assumption that SR and NS lead to food craving and loss of control, both characteristic of binge eating (Dawe & Loxton, 2004). Both (M)ANOVAs and discriminant analyses were performed to test these hypotheses.

Material and Methods

Participants and Procedure

Female patients between the age of 14 and 25 years (M=19.25, SD=3.00) were recruited at the Ghent university centre for EDs between September 2011 and December 2013. Patients diagnosed with AN-R, AN-B/P and BN were included in the study. Diagnoses were based on the DSM-IV criteria (DSM-IV-TR, APA, 2000) and were assigned by a trained psychologist. Patients reporting substance abuse were excluded from the study. This resulted in a sample of 91 girls (41 AN-R, 20 AN-B/P, and 30 BN). Average duration of the ED was 3.40 years (SD=2.83) ranging between less than 1 year and 11 years. Average Body Mass Index (BMI) was 17.70 (SD=3.56) ranging between 11.40 and 33.90. The study questionnaires were administered after the completion of active informed consents by the participants. The parents of participants under the age of 18 were informed about the study as well.

The HC group consisted of 292 girls between the age of 14 and 25 years (M=16.00, SD=2.03). Participants between the age of 14 and 19 years were recruited from nine different secondary schools. Schools were contacted at random and school principals received active informed consents prior to the study. Parents received passive informed consents, asking them to indicate on the form whether they did not want their child to participate. Participants were informed about the goal of the study and gave their active consent before the start of the study. Questionnaires were completed in class in the presence of a school teacher and a trained research assistant. Pupils were also weighed and measured separately from their classmates by the research assistant. Participants between 18 and 25 years were recruited by students of the Faculty of Psychology of the Ghent University. They contacted females within the appropriate age range by telephone or Facebook. Participants received the active informed consents as well as the questionnaires by mail and completed them at home. Average BMI in the HC sample was 21.32 (SD=3.36), ranging from 15.39 to 38.58. Girls scoring above the cut-off of 2.3 points on the total score of the Child-Eating Disorder Examination Questionnaire (ChEDE-Q; Bryant-Waugh, Cooper, Taylor, & Lask, 1996) were excluded from the study, based on the recommendations of Mond, Hay, Rodgers, Owen, and Beumont (2004). This study was approved by the university's ethics committee.

Materials

Child Eating Disorder Examination Questionnaire. The ChEDE-Q (Bryant-Waugh et al., 1996) was developed to measure pathologic eating behaviour in children or adolescents and contains 23 items divided in four subscales, namely Restraint (five items), Concerns about Eating (five items), Concerns about Body Shape (eight items) and Concerns about Weight (five items). All items consider the last four weeks and are to be answered on a seven point scale. The higher the score on the scale is, the greater the severity or presence of any given feature. This questionnaire was administered in the HC sample in order to exclude participants with a possible ED. Cronbach alphas were .73 for Restraint, .57 for Concerns about Eating, .85 for Concerns about Body Shape, and .72 for Concerns about Weight.

Sensitivity to Punishment and Sensitivity to Reward Questionnaire. The SPSRQ (Torrubia, Avila, Molto, & Caseras, 2001) was based on the RST and contains two subscales, one to measure SP and one to measure SR. Based on previous research (Matton, Goossens, Vervaet, & Braet, submitted) and because participants were included from the age of 14 years, the adapted version for adolescents was used. This questionnaire contains 22 items for each subscale, answered on a five point scale ranging from 'never' to 'always'. A high score on the SP and/or SR subscale indicates a high sensitivity to punishment or reward depending on the specific subscale. It has been shown that both the original and the adapted scales present satisfactory internal consistency as well as convergent and discriminant validity (Matton, et al., submitted; Torrubia et al., 2001). The validity of the Dutch SPSRQ has been shown to be similar to the validity of the original version in ED-patients (Beck, et al., 2009). Moreover, previous research has shown that the validity of this questionnaire in adolescent populations is good (Matton et al., submitted). Cronbach alphas in the present study were .90 for SP and .86 for SR in the clinical sample, and .88 for SP and .83 SR in the HC sample.

BIS/BAS Scales. The BIS/BAS Scales (Carver & White, 1994) were based on the RST and contain two subscales to measure SP and SR: a BIS scale (seven items) and a BAS scale (13 items). The items are answered on a four point scale, ranging from 'totally disagree' to 'totally agree'. A higher score on the subscales indicates higher SP or SR.

Since the revision of the RST (Gray & McNaughton, 2000), several authors have suggested to discriminate between original BIS-items measuring the revised FFFS and original BIS-items still measuring the BIS according to the revised RST. Especially the model of Johnson, Turner, and Iwata (2003) receives empirical support, both in clinical ED-samples as well as in community samples of adolescents (Beck et al., 2009; Matton et al., submitted). Therefore, both the original model of the BIS/BAS Scales as well as the model of Johnson et al. (2003) was used. In the model of Johnson et al. (2003), the BIS-items ‘even if something bad is about to happen to me, I rarely experience fear or nervousness’ and ‘I have few fears compared to my friends’ are considered as a separate revised-FFFS subscale. For the current study objectives, however, similar results were expected for the BIS- and the FFFS-scale as defined by the model Johnson et al. (2003), because both systems are regarded as the biological basis for SP.

The validity of the Dutch BIS/BAS Scales has been proven to be sufficient in ED-patients (Beck, et al., 2009). The validity in adolescents is less supported (Matton et al., submitted). Cronbach alphas in the clinical sample were .73 for BIS, .83 for BAS, .61 for BIS according to the model of Johnson et al. (2003) (BIS-John), and .62 for FFFS according to the model of Johnson et al. (2003) (FFFS-John). In the HC sample, Cronbach alphas were .74 for BIS, .75 for BAS, .72 for BIS-John, and .54 for FFFS-John.

Temperament and Character Inventory. The Temperament and Character Inventory (TCI; Cloninger et al., 1993) was developed to measure four inherent temperament dimensions, as well as three acquired character dimensions. In the present study, only the subscales HA (35 items) and NS (40 items) were used. The items are formulated as statements and have to be answered by marking the answer ‘correct’ (score 1) or ‘incorrect’ (score 0). A higher score on the subscales indicates a higher level of HA and/or NS. In the clinical sample, the full version of the TCI was used as part of the standard assessment. In the HC sample, the Shortened Temperament and Character Inventory (VTCI; Duijsens & Spinhoven, 2001) was used. This version of the TCI contains 15 items for each of the subscales and has a similar answer format. The VTCI was chosen in this sample due to the time limit given by the participating schools to complete the questionnaires. Because of the different number of items in both versions of the questionnaire, the mean scores instead of the total scores on HA and NS were calculated and used in the following analyses.

The internal consistency of the TCI in the clinical population could not be calculated, since only the total scores were available for the study due to the standard scoring procedure at the ED-centre. Nevertheless, Duijsens, Spinhoven, Goekoop, Spermon and Eurelings-Bontekoe (2000) have reported sufficient internal consistency of the TCI in clinical populations, with Cronbach alphas between .62 and .90 for the temperament subscales. The internal consistency of the VTCI in the present study was good with Cronbach alpha .82 for HA and .73 for NS in the non-clinical adolescent sample.

Data Analytic Plan

First, two separate MANOVAs were performed with the subscales related to avoidance (SP, BIS, BIS-John, FFFS-John, and HA) and the subscales related to approach (SR, BAS, and NS) as dependents and with Diagnosis (HC, AN-R, AN-B/P, or BN) as fixed factor. Significant MANOVAs were followed by separate ANOVAs for each subscale and post-hoc Tukey tests were conducted to examine the significance of the differences between the groups.

Next, a set of discriminant analyses was conducted to examine whether the SP related subscales could predict Clinical Status (ED or no ED), based on the hypothesis that SP related traits are transdiagnostically increased. A second set of discriminant analyses was performed to examine whether SR related subscales could predict Diagnosis, based on the hypothesis that SR related traits differ between ED-diagnoses. To avoid issues of multicollinearity among the predictors, separate discriminant analyses were performed for each subscale.

Results

Descriptives

The correlations between the subscales of the different temperament questionnaires are presented in Table 1. Positive associations were found between SP (SPSRQ), BIS (BIS/BAS Scales) and HA (TCI), as well as between SR (SPSRQ), BAS (BIS/BAS Scales) and NS (TCI). SP and SR were not correlated, BIS and BAS as well as HA and NS were negatively correlated. The mean scores of each group on the subscales of the SPSRQ, the BIS/BAS Scales and the (V)TCI can be found in Table 2.

Group Differences on SP, BIS, BIS-John, FFFS-John and HA

The model with SP, BIS, BIS-John, FFFS-John and HA as dependent variables was significant, with $F(15,705)=4.52$, $p<.001$, Pillai's Trace=.26, $\eta^2=.97$. Looking at the five variables separately, they were all significantly different depending on Diagnosis, with $F(3)=16.49$, $p<.001$, $\eta^2=.17$ for SP, $F(3)=24.73$, $p<.001$, $\eta^2=.24$ for BIS, $F(3)=20.59$, $p<.001$, $\eta^2=.21$ for BIS-John, $F(3)=16.53$, $p<.001$, $\eta^2=.17$ for FFFS-John and $F(3)=10.15$, $p<.001$, $\eta^2=.11$ for HA. Post-hoc Tukey tests showed that the scores on SP, BIS, BIS-John, FFFS-John and HA were significantly increased in all EDs compared to HCs.

Group Differences on SR, BAS and NS

The model with SR, BAS and NS as dependent variables was significant, with $F(9,711)=4.92$, $p<.001$, Pillai's Trace=.18, $\eta^2=.97$. Looking at the three variables separately, they were all significantly different depending on Diagnosis, with $F(3)=4.80$, $p<.01$, $\eta^2=.06$ for SR, $F(3)=6.32$, $p<.001$, $\eta^2=.07$ for BAS and $F(3)=2.95$, $p<.05$, $\eta^2=.04$ for NS. Post-hoc Tukey tests revealed that SR was significantly lower in AN-R patients and HCs compared to BN patients. BAS was significantly lower in AN-R patients compared to all other groups, and NS was significantly lower in AN-R patients compared to BN patients.

Prediction of Clinical Status by SP, BIS, BIS-John, FFFS-John and HA

The functions with SP, BIS, BIS-John, FFFS-John and HA as predictors were all significant with Wilk's $\Lambda=.88$, $\chi^2(1)=47.17$, $p<.001$, $\beta=.08$ for SP, Wilk's $\Lambda=.80$, $\chi^2(1)=81.66$, $p<.001$, $\beta=.29$ for BIS, Wilk's $\Lambda=.84$, $\chi^2(1)=66.87$, $p<.001$, $\beta=.38$ for BIS-John, Wilk's $\Lambda=.87$, $\chi^2(1)=51.90$, $p<.001$, $\beta=.78$ for FFFS-John, and Wilk's $\Lambda=.88$, $\chi^2(1)=31.04$, $p<.001$, $\beta=4.15$ for HA. The canonical correlations were .35, .44, .41, .36 and .34 respectively. Based on SP, 80.2% of the cases were correctly classified, based on BIS, 83.4% of the cases were correctly classified, based on BIS-John and FFFS-John, 80.4% en 78.6% of the cases were correctly classified respectively, and based on the HA-function, 68.6% of the cases was correctly classified (see Table 3).

Prediction of ED-diagnosis by SR, BAS and NS

The functions with SR, BAS and NS as predictors were all significant with Wilk's $\Lambda=.96$, $\chi^2(3)=14.51$, $p<.01$, $\beta=.10$ for SR, Wilk's $\Lambda=.95$, $\chi^2(3)=20.66$, $p<.001$, $\beta=.21$ for BAS and Wilk's $\Lambda=.96$, $\chi^2(3)=10.21$, $p<.05$, $\beta=4.90$ for NS. The canonical correlations were .20, .23 and .20 for SR, BAS and NS respectively. Based on SR, 78.0% of the cases was correctly classified, based on BAS 78.6% of the cases was correctly classified and based on NS 64.3% of the cases was correctly classified (see Table 4).

Discussion

The aim of the present study was to examine personality profiles co-occurring with specific ED-diagnoses. As such, we wanted to replicate previous findings and extend these by focusing on an age group with the highest incidence and prevalence of EDs (e.g. Hoek & Van Hoeken, 2003) as well as by integrating the three most widely used measures in this research area in one study (Glashouwer et al., 2014; Harrison et al., 2010; Jappe et al., 2011).

The results are consistent with the hypothesis of heightened SP/HA in all EDs regardless of the specific ED-diagnosis and regardless of the specific questionnaire being used. The findings regarding SR/NS are also in line with the expectations; with AN-R patients scoring significantly lower compared to BN patients, independent of the specific questionnaire being used.

The results on SR/NS further suggest that, when measured with the SPSRQ or the (V)TCI, HCs and AN-B/P patients may be situated between AN-R and BN patients, alhtough the level of SR/NS in AN-B/P patients did not significantly differ from AN-R patients or from BN-patients. When looking at the results on the BAS subscale, AN-R patients score not only significantly lower compared to BN patients, but also compared to HCs and AN-B/P patients whereas HCs, AN-B/P and BN patients do not significantly differ and show very similar scores. HCs instead of BN patients have the highest score when looking at the BAS subscale, although the differences between HCs, AN-B/P patients and BN patients on this subscale are remarkably small and not significant, so it doesn’t seem likely that BN patients truly score lower than HCs.

The discriminant analyses confirm this pattern of results, showing that the SP-related subscales significantly predict the clinical status of the participants, whereas the SR-related subscales significantly predict the specific ED-diagnosis. However, the classification table shows that, when using SR-related functions, most participants are classified as having no ED, so most EDs are missed. The fact that the discriminant functions are still significant might be due to the fact that most participants had no ED so classifying almost all participants in the non-clinical category automatically resulted in acceptable percentages of participants that were correctly classified. More EDs were recognized based on SP-related subscales, although the classification was less specific (ED or HC) compared to the classifications based on SR-related subscales (HC, AN-R, AN-B/P, or BN). These findings seem to imply that transdiagnostic and interdiagnostic differences on SP and SR exist, but that their influence is probably distal and the differences are therefore small.

Taken together, the results on SP/HA show a more consistent pattern, regardless of the specific questionnaire being used, compared to the results on SR/NS. This reflects the inconsistency in the existing literature on this topic (e.g. Harrison et al., 2010) and shows how the use of different instruments might lead to different conclusions. A first explanation for this might be that the BIS/BAS Scales are less valid for use in adolescents (Cooper, Gomez & Aucote, 2007; Yu, Branje, Keijsers & Meeus, 2011), which might bias the results. A second explanation is that all three questionnaires measure slightly different concepts. For example, the BIS/BAS Scales consists of items referring to generalized punishment and reward, whereas the items of the SPSRQ refer to specific punishment and reward, in line with the propositions of the RST (Matthews & Gilliland, 1999; Torrubia et al., 2001). This means that differences between ED-diagnoses may be more pronounced regarding specific rewards and less regarding general reward.

In general, SP/HA seems to be transdiagnostically increased compared to HCs, while a decrease in SR/NS for AN-R patients and/or an increase in SR/NS for BN-patients can be observed, depending on the specific instrument. These findings suggest that the combination of increased SP and decreased SR might make it ‘easier’ for AN-R patients to restrict their eating pattern compared to AN-B/P and BN patients. AN-B/P and BN patients probably have a profile of increased SP and increased SR, which might explain the conflict between drive for thinness and restriction versus binge eating seen in these patients.

Although the present findings are congruent with those reported in previous reviews (Cassin & Von Ranson, 2005; Harrison et al., 2010), it should be noted that most studies included in these reviews used the BIS/BAS Scales or the TCI. The few studies using the SPSRQ (Glashouwer et al., 2014; Jappe et al., 2011) reported both heightened SP and SR in AN-R and AN-B/P patients, whereas we found decreased SR in AN-R patients. It is therefore important to bear in mind that different perspectives exist on the way SR is involved in EDs and that these perspectives all receive mixed support, possibly depending on the specific sample characteristics.

In line with the present findings, a first hypothesis is that people with high SR are more sensitive to food cues (Beaver, Lawrence, van Ditzhuijzen, Davis, Woods, & Calder, 2006) and act more impulsively due to their increased sensitivity to the rewarding effects of food. As such, SR is thought to be associated with binge eating and as a consequence increased SR is expected in AN-B/P and BN patients compared to AN-R patients (Franken & Muris, 2005; Harrison et al., 2010; Van Den Berg et al., 2011). Another perspective departs from the assumption that impulsivity consists of two components, namely rash impulsivity/NS and SR (Dawe, Gullo, & Loxton, 2004). It is then hypothesized that especially rash impulsivity/NS and not SR is associated with binge eating because of the impulsive component in binge/purge behaviour. SR on the other hand is expected to be elevated in all EDs following this perspective, because SR, especially when measured with the SPSRQ, refers partly to the sensitivity for social rewards and rewards associated with appearance, which might be transdiagnostically increased (Glashouwer et al., 2014; Jappe et al., 2011). According to a third perspective, also departing from this multicomponent view on impulsivity, it is especially the combination of SR and rash impulsivity that leads to binge eating (Dawe & Loxton, 2004). According to this perspective, SR is associated with binge cravings and desire to binge, whereas rash impulsivity/NS is associated with the loss of control during binge eating and with the inability to resist binge cravings. This perspective is mainly based on clinical observations rather than on empirical results (Dawe & Loxton, 2004).

Despite the fact that the present findings are in line with the first and most widespread perspective, it seems important to conduct further research on the association between SP, SR and EDs, given the different existing hypotheses and the inconsistent support for all of them. To gain a better insight, future research should discriminate between different types of reward, since sensitivity for the rewards of food might increase from AN-R to AN-B/P and BN, whereas sensitivity for social rewards or rewards related to appearance might be transdiagnostically elevated. It is also necessary to conduct more longitudinal research, especially in adolescents at risk for developing an ED. First, it is unclear whether changes in SP and SR are a cause rather than a consequence of EDs. For example, Harrison et al. (2010) found that HA and NS scores tend to reduce after recovery from an ED. They argue that temperament might be altered due to the consequences of malnutrition in all ED-types. However, nutritional consequences have been studied mainly in AN-R patients and are less studied in BN patients, so the way in which malnutrition might add to changes in SP and SR is not fully understood yet (Harrison et al., 2010; Salvy & McCargar, 2002). Secondly, cross-sectional findings on personality profiles co-occurring with specific ED-diagnoses may be biased due to the fact that there is a lot of diagnostic cross-over over time (Milos, Spindler, Schnyder, & Fairburn, 2005). This means that a sample of AN-R patients may contain both patients who will ‘succeed’ in maintaining their restrictive eating pattern versus patients who do not and develop binge/purge behaviour over time. These two groups may also have different personality profiles, but that hypothesis has, to our knowledge, not been examined yet.

Finally, it is also necessary to account for moderators in the association between temperament and behaviour. For example, Claes, Robinson, Muehlenkamp, Vandereycken, and Bijttebier (2010) suggest that behaviour is not only triggered by temperament but is also directed by acquired skills such as effortful control. People with high scores on SP and SR may be more in need of effortful control or efficient problem solving skills than people with lower scores on SP and SR, which suggests a possible interaction between temperament and acquired skills. Future studies should examine this possible moderator in the relation between temperament and eating behaviour.

This study has several strengths. More specifically, three different ED-diagnoses were included as well as a HC group, whereas previous studies often focus solely on AN-R and AN-B/P (Glashouwer et al., 2014; Jappe et al., 2011) or fail to discriminate between AN-R and AN-B/P or to include a HC group (Harrison et al., 2010). Secondly, patients were included within the most vulnerable age range for the development of an ED. Moreover, three different self-report measures were combined in one study. Given the hypothesis that the inconsistent results reported in literature may be related to the inconsistent use of different questionnaires (Harrison et al., 2010), this might further add to our understanding of the association between temperament and ED-symptoms.

Some limitations have to be noted as well. First, the study was cross-sectional in nature, whereas conducting longitudinal studies on this topic is of great importance, as previously mentioned. Secondly, only self-report measures were used. Future research might include behavioural or neurological measures of SP and SR as well (Harrison et al. 2010). The sample size for each diagnostic category was also relatively small and Binge Eating Disorder (BED; DSM-V, APA, 2013) was not included. Moreover, the mean age of the clinical sample was higher than the mean age of the HC group, although the age range was similar. Further research might want to bring these limitations into account.

Conclusions

Taken together, the present findings suggest an increase in SP and HA across AN-R, AN-B/P and BN patients compared to HCs. SR and NS on the other hand seem to be decreased in AN-R patients or to be increased in BN patients, depending on the specific questionnaire being used. Further research is necessary to replicate these findings and to extend them by examining the mechanisms through which temperament might influence ED-symptoms.

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Tables

Table 1. Pearson correlations between the subscales of three temperament questionnaires.

	SP	SR	BIS	BAS	BIS-John	FFFS-John	HA	NS
SP	1	.07	.64**	-.28***	.62***	.47***	.74***	-37***
SR		1	.04	.55***	.09	-.11*	-.06	.34***
BIS			1	-.15**	.95***	.75***	.64***	-.20**
BAS				1	-.07	-.27***	-.35***	.41***
BIS-John					1	.50***	.61***	-.19**
FFFS-John						1	.54***	-.18**
HA							1	-.37***
NS								1

*Note. SP=Sensitivity to Punishment, SR=Sensitivity to Reward, BIS=Behavioural Inhibition System, BAS=Behavioural Activation System, BIS-John=Behavioural Inhibition System according to the model of Johnson et al. (2003), FFFS-John=Fight, Flight, Freeze System according to the model of Johnson et al. (2003), HA=Harm Avoidance, NS=Novelty Seeking; *p<.05, **p<.01, ***p<.001*

Table 2. Group characteristics for eating disordered patients and HCs.

	HC (n=292) M (SD)	AN-R (n=41) M (SD)	AN-B/P (n=20) M (SD)	BN (n=30) M (SD)	t-test HC vs. EDs t (df)
SP	62.71 (12.57)$_a$	74.47 (14.69)$_b$	73.23 (11.03)$_b$	74.27 (13.15)$_b$	-7.10 (367)***
SR	63.77 (10.13)$_a$	61.84 (11.50)$_a$	67.04 (11.45)$_{ab}$	71.02 (9.62)$_b$	-1.60 (367)
BIS	21.14 (3.66)$_a$	25.13 (2.61)$_b$	25.61 (2.40)$_b$	25.23 (2.76)$_b$	-11.56 (181.37)***
BAS	40.61 (4.56)$_a$	36.77 (5.69)$_b$	40.39 (6.55)$_a$	40.22 (5.36)$_a$	2.744 (108.73)**
BIS-John	15.40 (2.83)$_a$	18.11 (1.86)$_b$	18.39 (1.58)$_b$	18.31 (1.95)$_b$	-10.88 (203.56)***
FFFS-John	5.79 (1.33)$_a$	7.00 (1.18)$_b$	7.18 (1.01)$_b$	6.88 (1.01)$_b$	-8.37 (147.54)***
HA	.53 (.26)$_a$	.72 (.21)$_b$	.68 (.23)$_b$	.72 (.19)$_b$	-6.16 (220.52)***
NS	.46 (.22)$_{ab}$	.37 (.14)$_a$	.45 (.16)$_{ab}$	.52 (.21)$_b$	.93 (212.29)

Note. Means not sharing subscripts differ significantly, as indicated by post hoc contrasts (Tukey, p <.05).

*HC=Healthy Control, AN-R=Anorexia Nervosa-Restrictive subtype, AN-B/P= Anorexia Nervosa-Binge/Purge Subtype, BN=Bulimia Nervosa, ED=Eating Disorder, M=Mean, SD=Standard Deviation, SP=Sensitivity to Punishment, SR=Sensitivity to Reward, BIS=Behavioural Inhibition System, BAS=Behavioural Activation System, BIS-John=Behavioural Inhibition System according to the model of Johnson et al. (2003), FFFS-John=Fight, Flight, Freeze System according to the model of Johnson et al. (2003), HA=Harm Avoidance, NS=Novelty Seeking; *p<.05, **p<.01, ***p<.001*

Table 3. Classification of the sample based on the discriminant analyses using SP, BIS, BIS-John, FFFS-John or HA as discriminative factors.

		predicted group membership	
		ED	HC
SP	ED (n=80)	16 (20.0%)	64 (80.0%)
	HC (n=289)	9 (3.1%)	280 (96.9%)
BIS	ED (n=82)	34 (41.5%)	48 (58.5%)
	HC (n=292)	14 (4.8%)	278 (95.2%)
BIS-John	ED (n=82)	26 (31.7%)	56 (68.3%)
	HC (n=291)	274 (94.2%)	17 (5.8%)
FFFS-John	ED (n=79)	0 (0.0%)	79 (100%)
	HC (n=291)	0 (0.0%)	291 (100%)
HA	ED (n=90)	34 (37.8%)	56 (62.2%)
	HC (n=165)	24 (14.5%)	141 (85.5%)

Note. ED=Eating Disorder, HC=Healthy Control, SP=Sensitivity to Punishment, BIS=Behavioural Inhibition System, BIS-John=Behavioural Inhibition System according to the model of Johnson et al. (2003), FFFS-John=Fight, Flight, Freeze System according to the model of Johnson et al. (2003), HA=Harm Avoidance

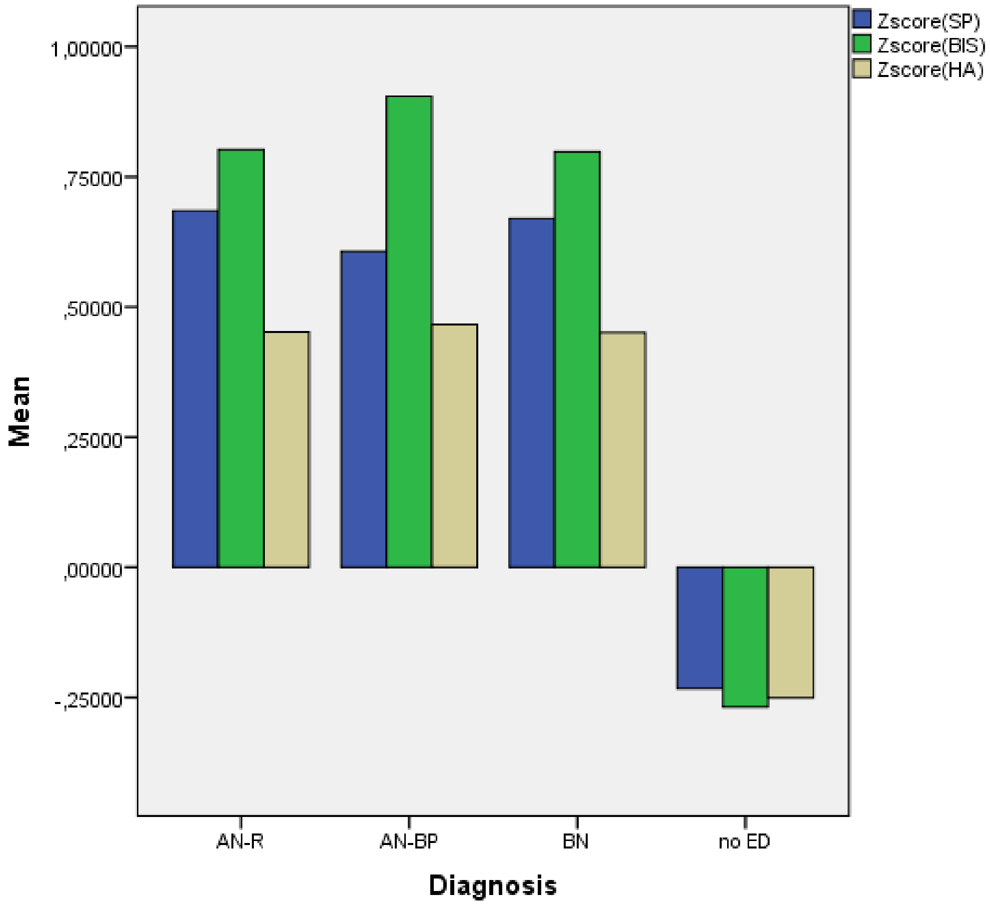
Table 4. Classification of the sample based on the discriminant analyses using SR, BAS, or NS as discriminative factors.

		predicted group membership			
		HC	AN-R	AN-B/P	BN
SR	HC (n=289)	288 (99.7%)	0 (0.0%)	0 (0.0%)	1 (0.3%)
	AN-R (n=37)	37 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	AN-B/P (n=18)	18 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	BN (n=25)	25 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
BAS	HC (n=292)	291 (99.7%)	1 (0.3%)	0 (0.0%)	0 (0.0%)
	AN-R (n=38)	35 (92.1%)	3 (7.9%)	0 (0.0%)	0 (0.0%)
	AN-B/P (n=18)	17 (94.4%)	1 (5.6%)	0 (0.0%)	0 (0.0%)
	BN (n=26)	26 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
NS	HC (n=162)	162 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	AN-R (n=41)	41 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	AN-B/P (n=19)	19 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	BN (n=30)	30 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)

Note. HC=Healthy Control, AN-R=Anorexia Nervosa-Restrictive subtype, AN-B/P= Anorexia Nervosa-Binge/Purge Subtype, BN=Bulimia Nervosa, SR=Sensitivity to Reward, BAS=Behavioural Activation System, NS=Novelty Seeking

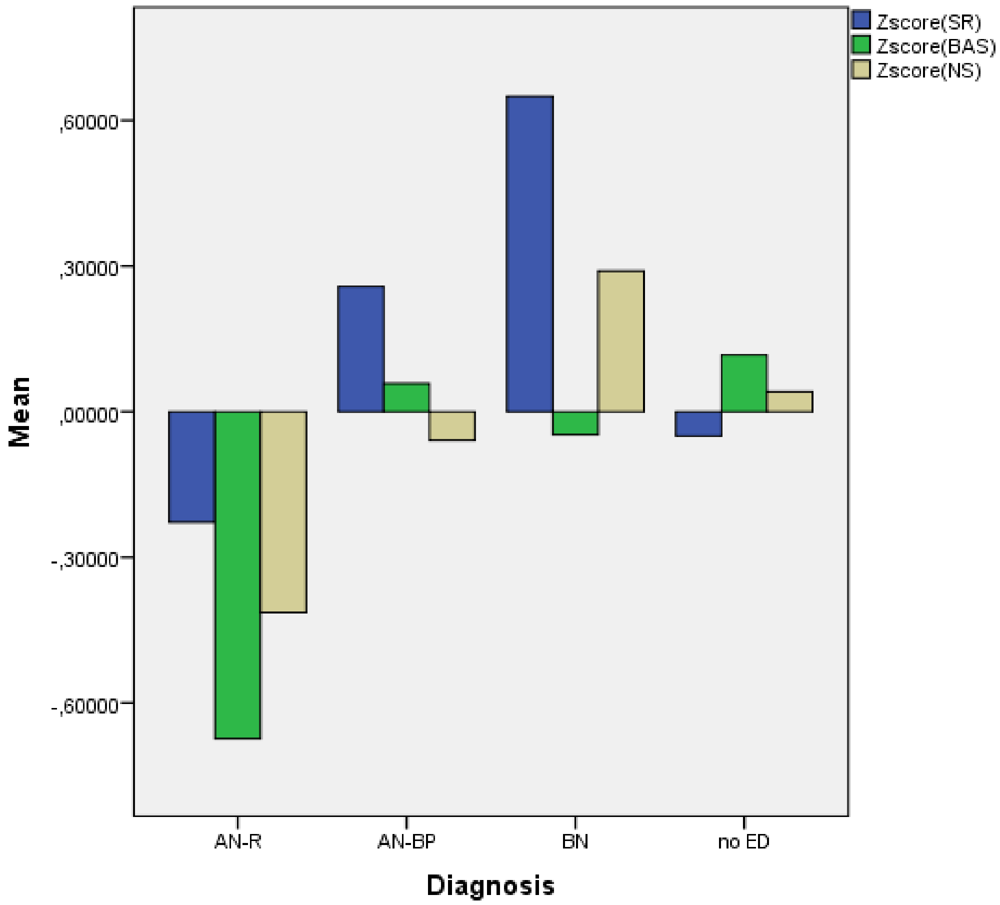
Figures

Figure 1. Standardized scores on SP (SPSRQ), BIS (BIS/BAS Scales) and HA (TCI).



Note. SP=Sensitivity to Punishment, SPSRQ=Sensitivity to Punishment and Sensitivity to Reward Questionnaire, BIS=Behavioural Inhibition System, BIS/BAS Scales=Behavioural Inhibition System and Behavioural Activation System Scales, HA=Harm Avoidance, TCI=Temperament and Character Questionnaire, AN-R= Anorexia Nervosa – Restrictive subtype, AN-B/P= Anorexia Nervosa – Binge/Purge Subtype, BN=Bulimia Nervosa, ED=Eating Disorder

Figure 2. Standardized scores on SR (SPSRQ), BAS (BIS/BAS Scales) and NS (TCI).



Note. SR=Sensitivity to Reward, SPSRQ=Sensitivity to Punishment and Sensitivity to Reward Questionnaire, BAS=Behavioural Activation System, BIS/BAS Scales=Behavioural Inhibition System and Behavioural Activation System Scales, NS=Novelty Seeking, TCI=Temperament and Character Questionnaire, AN-R= Anorexia Nervosa – Restrictive subtype, AN-B/P= Anorexia Nervosa – Binge/Purge Subtype, BN=Bulimia Nervosa, ED=Eating Disorder

Chapter 3

Sensitivity for cues predicting reward and punishment in young women with eating disorders [2]

Abstract

There is increasing evidence that sensitivity to reward and punishment may be involved in eating disorders (EDs). Most studies used self report measures and focused on the experience of positive/negative affect in rewarding/punishing situations, whereas the implied proneness to detect signals of reward/punishment is thus largely ignored. Therefore, this pilot study used a spatial orientation task (SOT) to examine transdiagnostic and interdiagnostic differences in attentional biases towards signals of reward and punishment. Participants (14-29 years) were patients with Anorexia Nervosa of the Restricting type (n=20) and of the Binge/Purge type (n=7), Bulimia Nervosa (n=9), and a group of non-symptomatic individuals (n=23). The findings support the view that heightened punishment sensitivity is a transdiagnostic feature of EDs and show that the SOT is sensitive to individual differences, thereby sustaining its usefulness as a behavioural measure of reinforcement sensitivity within the context of EDs.

[2]Matton, A., de Jong, P., Goossens, L., Jonker, N., Vervaet, M., De Schryver, N., & Braet, C. (under review). Sensitivity for Cues Predicting Reward and Punishment in Young Women with Eating Disorders. *European Eating Disorders Review*.

Introduction

Eating disorders (EDs) are severe and persistent mental disorders (Castellini, et al., 2011; Milos, Spindler, Schnyder, & Fairburn, 2005) that are still not adequately understood. There is accumulating evidence indicating that temperament might be involved in the development and course of EDs (Atiye, Miettunen, & Raevuori-Helkamaa, 2015; Cassin & Von Ranson, 2005; Harrison, O'Brian, Lopez, & Treasure, 2010). More specifically, individual differences in temperament traits, that determine the tendencies to engage in approach or avoidance behaviour as well as affective reactivity to experiences, can determine vulnerabilities for the development of EDs (Atiye et al., 2015; Cassin & Von Ranson, 2005; Harrison et al., 2010). However, there are some important unresolved issues and inconsistent findings concerning the specific role of different temperament traits. These may, at least partly, be due to differences between the samples that were studied and to the fact that often self-report measures of temperament traits were used, which may not always tap the core temperamental characteristics.

The main ED-types that are defined by the Diagnostic and Statistical Manual of Mental Disorders 5th edition (DSM-5; American Psychiatric Association (APA), 2013) are Anorexia Nervosa of the Restrictive type (AN-R), Anorexia Nervosa of the Binge/Purge type (AN-B/P), Bulimia Nervosa (BN), and Binge Eating Disorder (BED). Most temperament research focused on AN and BN (e.g., Harrison et al., 2010), especially since these disorders share the core symptom of overvaluation of the self in terms of body shape and weight. This cognitive symptom is translated into restrictive eating and underweight in the case of AN-R, into restrictive eating combined with binge/purge behaviour and underweight in the case of AN-B/P and into binge/purge behaviour, sometimes combined with periods of restriction and mostly a normal weight in the case of BN (APA, 2013; Fairburn, Cooper & Shafran, 2003).

There is increasing evidence that there may be both differences and similarities in the etiology of these EDs, also in terms of temperamental traits (Hilbert et al., 2014). Two prominent traits that have often been linked to EDs are Sensitivity to Reward (SR) and Sensitivity to Punishment (SP) (e.g. Harrison et al., 2010). These traits are defined as the proneness to detect signals of reward/punishment in the environment and to experience positive/negative affect in rewarding/punishing situations, respectively (Davis & Fox, 2008). SR and SP stem from the Reinforcement Sensitivity Theory (Gray, 1970, 1982, 1987; Gray & McNaughton, 2000), positing that there are three biological systems lying at the basis of human motivational behaviour and emotion. These are the Behavioural Activation System, activated by signals of reward and leading to approach behaviour, the Behavioural Inhibition System, activated by goal conflict and leading to inhibition, and the Fight Flight Freeze System, activated by signals of punishment and leading to avoidant or defensive behaviour (Gray, 1970, 1982, 1987; Gray & McNaughton, 2000). The trait SR is determined by the sensitivity of the Behavioural Activation System, whereas SP is determined by the sensitivity of the Behavioural Inhibition System and the Fight Flight Freeze System (Gray, 1970, 1982, 1987; Gray & McNaughton, 2000; Harrison et al., 2010; Matton, Goossens, Vervaet, & Braet, 2015).

Because SP is associated with inhibition and avoidant behaviour as well as with negative affectivity, it has been argued that heightened SP would be characteristic for all ED subtypes. In line with this, empirical research using self-report questionnaires indeed showed that heightened SP is a transdiagnostic feature of EDs (Harrison et al., 2010; Matton et al., 2015). In contrast, because high SR is thought to be associated with impulsive approach behaviour and with a higher sensitivity to the rewarding effects of food, it has been argued that SR would be heightened in BN, but lowered in AN-R

(Harisson et al., 2010; Matton et al., 2015). However, the empirical evidence for the hypothesized role of SR in the various eating disorders is mixed (Harisson et al., 2010). Some studies did indeed find that patients with AN-R scored lower on SR compared to patients with BN (Harrison et al., 2010; Matton et al., 2015), yet other studies reported heightened levels of SR in AN-R (Glashouwer, Bloot, Veenstra, Franken, & De Jong, 2014; Harisson et al., 2010; Jappe et al., 2011). Whereas many studies did not discriminate between AN-R and AN-B/P (Harrison et al., 2010; Jappe et al., 2011), those who did examine both ED types separately reported higher levels of SR in AN-B/P compared to healthy controls (Glashouwer, et al., 2014) or suggested that the level of SR in AN-B/P was situated in between the level of SR in AN-R and BN (Matton et al., 2015).

Most of these results are based on adult samples or on a mixture of adolescents and young adults (Glashouwer et al., 2014; Harisson et al., 2010; Jappe et al., 2011; Matton et al., 2015). In a non-clinical sample of adolescent girls specifically (mean age 14.13 years), Walther and Hilbert (2016) found high SR, instead of high SP, to be positively associated with restrained eating. In an even younger cohort with participants aged 6 to 13 years, a positive association between SR and overeating was found (van den Berg, Pieterse, Malik, Luman, van Dijk, Oosterlaan, & Delemarre-van de Waal, 2011). Matton, Goossens, Braet and Vervaet (2013) found in a sample of adolescents aged 14 to 19 years that especially high SP was associated with restrained eating, while especially high SR was associated with external eating. Together, these questionnaire studies among non-clinical adolescent samples, provide some additional evidence for the potential role of (subjective) SR and SP in EDs, but similar to the studies in adults, there were various inconsistencies in the findings.

Regarding these inconsistencies, it is important to note that the definition of SR and SP posits that these traits influence both the proneness to detect cues predicting reward/punishment as well as the intensity of the positive/negative affect that is elicited by reward/punishment respectively (Davis & Fox, 2008). While self-reports might be suited to measure this latter component, it seems rather difficult to measure the first component by means of self-reports. One possible answer to this problem is to use performance based measures.

In the domain of reward-related decision making, several performance based measures have been used in previous research, such as delay discounting tasks and gambling tasks. By and large these studies showed that adult patients with an ED tend to score poor on reward-related decision making, regardless of the specific ED type (Wu, Brockmeyer, Hartmann, Skunde, Herzog, & Friederich, 2016). In addition, the meta-analysis of Wu et al. (2016) indicated that this pattern was restricted to non-food related rewards and much weaker in adolescents than in adult samples (Wu et al., 2016). Although these findings point to the potential relevance of using behavioural measures of reward-related decision making within the context of EDs, the tasks that were used in these studies provide no straightforward indices of individuals' proneness to detect cues predicting reward or punishment.

Therefore, the current pilot study used a reaction time task that was specifically designed to examine the sensitivity for cues predicting non-food related reward/punishment. More specifically, a Spatial Orientation Task (SOT) was used which was originally developed by Derryberry and Reed (1994). Conceptually similar research in the context of substance use and addiction has already shown that the SOT can be successfully employed as an index of attentional bias for cues predicting reward/punishment (Colder &

O'Connor, 2002; van Hemel-Ruiter, de Jong, Oldehinkel, & Ostafin, 2013; van Hemel-Ruiter, de Jong, Ostafin, & Oldehinkel, 2015). Thus this task seems well-equipped to assess individuals' sensitivity for predictors of reward/punishment. As an interesting feature, the SOT allows to differentiate between differences in both attentional engagement and attentional disengagement (Posner, Inhoff, Friedrich, & Cohen, 1987; van Hemel-Ruiter et al., 2013). This provides the opportunity to examine whether enhanced sensitivity for cues predicting reward/punishment is expressed as an enhanced engagement or as a difficulty to disengage from these signals (or both). Taking both components of attentional bias in consideration might be important based on findings within the context of substance use and anxiety disorders showing that attentional engagement towards and difficulties with attentional disengagement from reward-related cues may independently contribute to the development of problematic behaviour, such as substance misuse (Koster, Crombez, Verschuere, & De Houwer, 2004; van Hemel-Ruiter et al., 2013). This might be the case in EDs as well. It has been previously found that patients with a restrictive ED showed attentional avoidance of high-fat food related cues, but did not show facilitated disengagement from these cues (Veenstra & de Jong, 2012). Although these findings were limited to patients with AN-R and to food-related cues, they imply that the processes of attentional engagement versus attentional disengagement may play differential roles in EDs as well.

In addition, the SOT can discriminate between more automatic attentional biases and attentional processes that are more subject to voluntary control by manipulating the delay between cues and targets (i.e., 250 ms delay versus 500 ms delay) (van Hemel-Ruiter et al., 2013). It has been argued that both organistic relevance and goal relevance are important factors governing attentional processes (Tapper, Pothos, & Lawrence, 2010). The former might be measured in short delay trials, whereas the latter might play a more important role in long delay trials. This allows examining whether EDs or specific ED subtypes are associated particularly with involuntary processes, with effortful processes, or with both, and thus whether or not the level of ‘automatic’ SR and SP is similar to the level of ‘effortful’ SR and SP.

To the best of our knowledge, the current study is the first to specifically investigate differential attention with the spatial orientation task to cues predicting reward/punishment in a sample of patients with an ED. Insight into the way patients with an ED process cues predicting reward/punishment compared to individuals without an ED, may lead to a more comprehensive insight into the role of SR and SP in EDs. This is not only relevant for improving our understanding of the processes involved in EDs, but also for screening and diagnostic purposes, as well as for potential training programs, such as attention training (Boutelle, Kuckertz, Carlson, & Amir, 2014). As such, the major aim of the current pilot study was to examine transdiagnostic and interdiagnostic differences in attentional biases towards signals of reward/punishment in patients with AN-R, patients with a binge/purge ED, being AN-B/P and BN, and a non-ED control group. It was anticipated that attentional bias towards signals of reward would be heightened in patients with a binge/purge ED and lowered in patients with AN-R. In addition, it was anticipated that attentional bias towards punishment would be generally heigthened in patients with an ED compared to the non-symptomatic control group (Harrison et al., 2010, Matton et al., 2015). Because little research has been conducted in this area before, no a priori predictions were made about the possible direction of differences between engagement and disengagement trials nor between short delay versus long delay trials. However, based on the findings of Veenstra and de Jong (2012) it was assumed that interdiagnostic differences would be more pronounced on engagement trials compared to disengagement trials.

It was chosen to focus on adolescents and young adults (14-29 years), as it has been found that the prevalence and incidence of EDs is highest in this age group (Hoek & Van Hoeken, 2003). Because previous research also showed that SR might be temporarily enhanced in adolescents (Galvan, 2013), and studies on reward-related decision making suggest differences in reward processing between adolescents and adults with an ED (Wu et al., 2016), the association between age and the outcomes on the SOT were taken into account as well.

Materials and Methods

Participants and Procedure

A clinical sample of 36 female inpatients diagnosed with AN-R (n=20), AN-B/P (n=7) or BN (n=9) was recruited via a center for EDs at a university hospital. The diagnoses were based on DSM-IV-TR criteria (APA, 2000) and were assigned by trained psychiatrists and psychologists. The age of the participants varied between 14 years and 29 years (M=18.78, SD=4.05) and the average self-reported duration of the ED varied between 1 and 14 years (M=3.21; SD=3.73). The BMI of participants with AN-R or AN-B/P varied between 12.93 and 17.50 (M=15.05, SD=1.38). In participants with BN, the BMI varied between 17.54 and 21.57 (M=19.72, SD=1.17). The SOT was completed by the participants in a separate room at the hospital during a therapy-free moment and in the presence of a researcher. Informed consent was obtained from the participants as well as from their parents in the case of underaged participants. The participants were informed that their participation was voluntary and that they were free to quit the study at any time. They were also assured that their participation in the study was independent from their treatment at the ED center.

A non eating disordered control sample consisting of 23 female participants was recruited via secondary schools and among university students. Participants were excluded from the control sample if they had an average score of four points or more on one or more of the subscales of the Child Eating Disorder Examination Questionnaire (ChEDE-Q; Bryant-Waugh, Cooper, Taylor, & Lask, 1996; Decaluwé & Braet, 1999 adapted from Fairburn & Beglin, 1994). Participants with a BMI of 17.5 or less or with a BMI of more than 25 were excluded as well to rule out the possible association between under- or overweight and SR and SP (Davis & Fox, 2008). These criteria resulted in the exclusion of nine participants of the original 32 participants, leading to the final sample of 23 participants. The age of the participants varied between 14 and 28 years ($M=17.43$; $SD=2.71$). The mean age in the control sample was similar to the mean age in the clinical sample ($t(58)=-1.37$, $p>.05$). The BMI of the participants in the control sample varied between 18.29 and 24.46 ($M=20.94$; $SD=1.83$). Of the total sample, 11 participants were recruited via secondary schools by psychology students. The remaining 12 participants were university students who received credits for participating in the study. All participants of the control sample completed the SOT in a separate room at the university in the presence of a researcher. Informed consent was obtained from the participants as well as from their parents in the case of underage participants. The participants were informed that their participation was voluntary and that they were free to leave the study at any time. After the completion of the computer task, the participants were asked to complete the ChEDE-Q and they were weighed and measured by the researcher. The study procedure was approved by the ethics committees of both the participating university hospital and the university.

Spatial Orientation Task

General Task Outline. The Spatial Orientation Task (SOT; Derryberry & Reed, 1994; 2002) was developed to measure the level of attentional engagement towards and the difficulty to disengage attention from places where reward or punishment is expected (i.e. attentional bias towards signals of reward or punishment).

In this task, participants are asked to respond as quickly as possible to a neutral target that is preceded by a cue in order to gain points or to avoid losing points. Participants have to respond on the target by pressing the ‘b’ key of the computer and their score is presented in the middle of the screen. There are two types of games: in positive games, the participants win 10 points if they respond sufficiently fast and their score remains unchanged if they respond too slowly, whereas in negative games, the participants lose 10 points if they respond too slowly and their score remains unchanged if they respond sufficiently fast. When participants respond before the target has appeared, or respond when no target appears at all (catch trials) they lose 10 points regardless of the game type. The complete task consists of eight games, four positive and four negative which are alternated every two games. Each game consists of 32 cued, 16 uncued, and eight catch trials that are presented in random order. The eight games are preceded by four training games (two positive and two negative).

In the present study, the task was performed on a Dell Inspiron 6000 using E-prime software version 2.2 with the participants 50 cm removed from the screen. Before the beginning of the task, participants were encouraged verbally by the researcher to try to win as much points as possible in positive games and to try to lose as few points as possible in negative games.

Cues Signalling Reward or Punishment. Each trial within each game begins with the appearance of two vertical black bars on a white background at the possible cue and target locations (i.e., left and right of the participant's score in the middle of the screen) (see Figure 1). The participants are asked to focus on their score, which is also presented in black on the white background. The score is turned off for 200 ms and then returns for 250 ms, after which the cue appears at the location of one of the two vertical bars (see Figure 2 and Figure 3). After 250 ms (i.e., short delay condition) or 500 ms (i.e., long delay condition) the target (i.e., small grey rectangle) is displayed in the middle of the cue (i.e., cued trial) (see Figure 4) or in the middle of the vertical bar on the opposite side of the cue (i.e., uncued trial) (see Figure 5). This cue acts as a signal of reward or punishment by predicting the chances that the participant will win or lose points. Participants are told that a blue arrow pointing upward (see Figure 2) predicts that, when the target appears in that location (i.e., cued trial), the participant will be likely to respond in time (i.e., easy trial), whereas if the target appears in the opposite location (i.e., uncued trial) the participant will be unlikely to respond in time (i.e., hard trial). Similarly, participants are informed that a red arrow pointing downward (see Figure 3) predicts that, when the target appears in that location (i.e., cued trial), the participant will be unlikely to respond in time (i.e., hard trial), whereas if the target appears in the opposite location (i.e., uncued trial), the participant will be likely to respond in time (i.e., easy trial). The participants are also told that the cues indicate not only the chances of responding in time, but also the probable location of the target. More specifically, during the task 2/3 of the targets appear in the cued location, and occasionally no target appears (e.g., catch trials) although participants are not informed about these exact numbers. Taken together, this means that blue arrows predict reward (in positive games) or nonpunishment (in negative games), whereas the red arrows predict nonreward (in positive games) or punishment (in negative games). The attentional bias for cues predicting reward or punishment is then inferred from (a) the participant's difference score based on the reaction time (RT) in cued red versus cued blue trials in positive and negative games respectively (i.e., the engagement effect) and from (b) the participant's difference score based on the RT in uncued red versus uncued blue trials (i.e., the disengagement effect) in positive and negative games respectively (see Table 1).

Hard and Easy Trials. In order to create the hard and easy trials, the time to respond on a cued blue target is equal to the own mean RT + 0.55SD, resulting in a sufficiently fast response in 75% of the time (i.e., easy trial), whereas the time to respond on an uncued blue target is equal to the own mean RT – 0.55SD, resulting in a too slow response in 75% of the time (i.e., hard trial). Analogously to the blue arrow cues, red arrow cued trials result in too slow responses in 75% of the time (i.e., hard trials), whereas red arrow uncued trials result in sufficiently fast responses in 75% of the time (i.e., easy trials). These personal cut-off scores for fast and slow responses are calculated at the end of each game. However, because RTs tend to be 25 ms slower after short delays between the cue and the target, 12 ms were added to the cut-off for trials with a short delay (e.g. 250 ms) and were subtracted from the cut-off for trials with a long delay (e.g. 500 ms) (van Hemel-Ruiter et al., 2013).

Feedback. 500 ms after each response (or 1 s in the case of a catch trial), the cue and target are removed and the two black bars reappear. A feedback signal is presented below the score. This signal takes the same form as the cues, and is thus a blue arrow pointing upward (see Figure 6) or a red arrow pointing downward (see Figure 7). The blue arrow pointing upward implicates that a fast response was given (or no response in the case of catch trials), whereas the red arrow pointing downward implicates that a too slow response was given (or that the participant pressed the ‘b’ key in a catch trial, or that the participant pressed before the target appeared). After 250 ms the score is updated if necessary. Next, a randomly selected delay of 500 ms or 1 s is introduced, after which the next trial begins by removing the feedback arrow as well as the score for 200 ms. The score remains visible during the complete game, after which it is reset to zero at the start of a new game.

Task Validity. Summarized, this task allows to measure attentional bias towards both cues predicting reward and cues predicting punishment by including both positive and negative games, in which the emphasis is on reward versus punishment, respectively. Moreover, both attentional engagement as well as difficulty with attentional disengagement are measured by including both cued and uncued trials. The different delays between the cue and the target further allow to discriminate between automatic attentional biases (short delay of 250 ms) and attentional biases that are subject to more voluntary control (long delay of 500 ms). Previous research has shown that the SOT is a valid task for assessing attentional bias towards signals of punishment and reward (Colder & O’Connor, 2002; Derryberry & Reed, 2002; van Hemel-Ruiter, et al., 2013; van Hemel-Ruiter, et al., 2015). Supporting the validity of the SOT as a measure of individual differences, earlier research in the context of substance abuse showed that the strength of participants’ attentional engagement towards signals of reward was positively associated with alcohol use in undergraduates (Colder & O ‘Connor, 2002) as well as adolescents (van Hemel-Ruiter et al., 2013), and showed predictive validity for the increase in using illicit drugs from baseline to three years follow up (van Hemel-Ruiter et al., 2015).

Child Eating Disorder Examination Questionnaire.

The Child Eating Disorder Examination Questionnaire (ChEDE-Q; Bryant-Waugh et al., 1996; Decaluwé & Braet, 1999 adapted from Fairburn & Beglin, 1994) is based on the transdiagnostic model of EDs (Fairburn, et al., 2003) and was developed to measure pathologic eating behaviour in children and adolescents. This version of the questionnaire was used, since participants were included from the age of 14 years and because there are no substantive differences between the items of the ChEDE-Q and the items of the Eating Disorder Examination Questionnaire developed for adults (Fairburn & Beglin, 1994). The ChEDE-Q contains 23 items divided in four subscales, namely Restraint (five items), Concerns about Eating (five items), Concerns about Body Shape (eight items), and Concerns about Weight (five items). All items consider the last four weeks and are to be answered on a seven point scale. The higher the score on the scale, the greater the severity or presence of any given feature. The validity of ChEDE-Q in Dutch adolescents has been shown repeatedly (e.g. Decaluwé & Braet, 2004; Goossens & Braet, 2010). Cronbach's alphas for the ChEDE-Q in the current study were .77 for Restraint, .64 for Concerns about Eating, .94 for Concerns about Body Shape, and .90 for Concerns about Weight. This questionnaire was solely used to exclude participants with heightened ED symptoms that may reflect an ED, from the control group. Therefore, a mean score of four points or more on one or more of the subscales was used as a cut-off, based on the guidelines of previous studies in young adolescent girls (Carter, Stewart, & Fairburn, 2001) and young adult women (Mond, Hay, Rodgers, & Owen, 2006).

Data Analytic Plan

First, it was tested whether the general response pattern of the participants was in line with the expectations based on the task design. This was done by conducting paired samples t-tests to compare the mean RTs in cued blue versus cued red trials as well as in uncued blue versus uncued red trials. A general engagement effect (faster responses in cued blue trials compared to cued red trials) was expected, as well as a general disengagement effect (faster responses in uncued red trials compared to uncued blue trials). This was done for both positive and negative games and for short and long delays between the cue and the target.

Next, eight SOT-indices were calculated based on the RTs in different trial types. In positive games, attentional engagement towards expected reward as well as difficulty of attentional disengagement from expected reward were measured for short and long delays, resulting in four indices. Higher scores on these variables indicate a larger attentional bias towards cues predicting reward. Similarly, negative games resulted in four indices indicating the level of attentional engagement towards expected punishment and difficulty to disengage attention from expected punishment both for trials with short and long delays. Higher scores on the resulting four variables indicate a larger attentional bias towards cues predicting punishment.

In Table 1 the specific calculation of the eight SOT-variables is explained. First, the Reward Engagement scores are calculated for both short and long delays. Since participants generally respond faster to a target that appears in an area that they are attending to than to a target that appears in an area on which they are not focused yet (Posner et al., 1987), the difference in RT between easy cued trials and hard cued trials gives an indication of the level of attentional bias towards cues predicting reward (in positive games). Next, the Reward Disengagement scores are calculated for both short and long delays. Here, the difference in RT in trials with uncued targets that are preceded by a blue arrow (easy cue) and trials with uncued targets that are preceded by a red arrow (hard cue) gives an indication of the difficulty to disengage attention from locations of expected reward, and as such gives a second indication of the level of attentional bias towards cues predicting reward (in positive games). Attentional bias towards punishment is analogously inferred from negative games leading to four new SOT variables: Short/Long Delay Punishment Engagement and Short/Long Delay Punishment Disengagement.

Since both the age of the participants as well as the chronicity of an ED could potentially affect the results, the correlations between age, self-reported illness duration and the SOT outcomes were calculated in order to determine the necessity to include these variables as covariates in the following analyses.

Next, differences on the eight SOT-variables between AN-R, binge/purge ED, and controls were examined first via Manova and contrast calculations testing the significance of linear and quadratic effects. In addition, separate one-way Anova's were conducted to compare the means on the SOT-outcomes between specific subgroups. In the first contrast, controls were compared with the total clinical sample in order to examine the hypothesis that patients with an ED have a larger bias towards punishment compared to controls, regardless of the specific ED diagnosis. In the second contrast, patients with AN-R and patients with a binge/purge ED were compared with each other to examine the hypothesis that patients with AN-R are less sensitive for cues predicting reward compared to patients with a binge/purge ED, while no difference in attentional bias towards punishment was expected between patients with AN-R and patients with a binge/purge ED. The diagnoses AN-B/P and BN were merged in one category, because both ED subtypes are characterized by binge/purge behaviour and are thought to be more similar to each other in terms of temperament compared to patients with AN-R (Claes, Robinson, Muehlenkamp, Vandereycken, & Bijttebier, 2010). It was not chosen to create a general AN group including both AN-R and AN-B/P patients because this could bias the results since differences in the level of SR are expected between purely restrictive versus binge/purge EDs (Matton, et al., 2015; Schag, Schonleber, Teufel, Zipfel, & Giel, 2013). The method of contrast calculations leads to optimal power which is especially relevant given the small sample sizes of the clinical groups.

Results

Descriptive Statistics

Attesting to the validity of the task, participants generally showed enhanced engagement to cues predicting reward (positive games) or nonpunishment (negative games) compared to cues predicting frustrative nonreward (positive games) or punishment (negative games). The pattern of disengagement did not systematically vary as a function of the different trial types. Only one significant disengagement effect was found (see Table 2). Age and self-reported illness duration were not associated with attentional bias to reward or punishment in the SOT (see Table 3). The mean scores on each SOT-variable for controls, patients with AN-R, and patients with a binge/purge ED can be found in Table 4.

Attentional Bias Regarding Signals Predicting Reward

Only for the long delay disengagement index the MANOVA showed a significant main effect of group (see Table 5).This effect seems mainly carried by the relatively high scores of the AN-R group as was supported by the finding that the quadratic but not the linear contrast was significant (see also Table 4). Accordingly, analyses of the a priori contrasts indicated that patients with AN-R scored significantly higher than patients with a binge/purge ED (see Table 6). This indicates that patients with AN-R showed a stronger difficulty to disengage their attention from places of expected reward (stronger SR) than patients with a binge/purge ED.

Attentional Bias Regarding Signals Predicting Punishment

Only for the long delay disengagement index there was a significant main effect of group (see Table 5). This effect was mainly carried by the relatively high scores of the binge/purge ED group which was supported by the finding that only the linear contrast was significant (see also Table 4). Accordingly, analyses of between group contrasts indicated that patients with binge/purge ED showed significantly higher disengagement scores than patients with AN-R (see Table 6). Thus patients with binge/purge ED showed a stronger difficulty to disengage their attention from places of expected punishment (higher SP) than patients with AN-R.

In addition, there was a non-significant main effect of group ($p<.07$) with regard to the short delay engagement trials, indicating that the groups tended to show differential attentional engagement on the short delay trials. Contrast analyses indicated that this effect was mainly carried by the finding that patients with an ED showed higher engagement scores than the control group. Thus patients with an ED showed a relatively strong inclination to direct their attention towards places of expected punishment (high SP). Although the main effect of group did not reach significance for the long delay engagement trials, the contrast analyses showed a similar pattern as for the short delay trials. Thus also on trials that are more under voluntary control, patients with an ED showed relatively strong attentional engagement for cues that predict punishment.

Discussion

The present pilot study sought to investigate temperamental differences in Sensitivity to Reward (SR) and Sensitivity to Punishment (SP) between non-symptomatic controls, patients with AN-R, and patients with a binge/purge ED via a performance based measure. This enabled us to measure the sensitivity for cues predicting reward or punishment rather than measuring the intensity of the affect that is experienced in rewarding or punishing situations, which was the main focus of previous research. To the best of our knowledge, the task used here to operationalize SR and SP, has not been used before in patients with an ED. As such an important goal was to evaluate the relevance and potential of this task for future research regarding SR and SP in EDs. The major findings can be summarized as follows: (i) patients with AN-R showed a relatively strong difficulty to redirect their attention away from signals of rewards compared to patients with a binge/purge ED, (ii) specifically patients with a binge/purge ED showed a stronger difficulty to direct their attention away from places of expected punishment compared to patients with AN-R, whereas (iii) more generally patients with an ED showed heightened attentional bias towards signals of punishment.

The results clearly show that the SOT is sensitive to differences between groups and may provide relevant complementary information regarding individuals' sensitivity to signals of punishment or reward. The pattern of findings in terms of differential SR and SP as a function of ED seems slightly different from the results based on self-report questionnaires (e.g. Harrison et al., 2010). This could be both related to potentially different roles for attention allocation towards signals predicting reward/punishment versus affective responses to actual reward/punishment as well as to difficulties with assessing SR and SP on a self-report basis.

The results also show that there may be differences in attentional bias towards cues predicting reward and punishment between non-symptomatic controls and patients with an ED. First, regarding SR, a significant difference was found in the long delay reward disengagement trials, indicating that patients with AN-R tended to show a stronger difficulty to disengage from cues predicting reward than patients with a binge/purge ED. This suggests, opposite to the expectations, that patients with a restrictive ED are more sensitive to cues predicting reward than patients with a binge/purge ED. However, this tendency in patients with AN-R of showing a greater difficulty to redirect their attention away from signals of reward, compared to patients with a binge/purge ED, was not paralleled with an enhanced initial orientation towards these cues nor with an increased score on short delay reward disengagement trials. Thus different from earlier findings in the context of substance use (e.g., van Hemel-Ruiter et al., 2013), only weak evidence was found regarding decreased/enhanced sensitivity for cues signalling potential reward in specific diagnostic categories. The absence of evidence for increased SR in patients with a binge/purge ED and decreased SR in patients with AN-R as indexed by the SOT resonates the (inconsistent) findings of studies using self-reports of SR (Glashouwer, et al., 2014; Harisson et al., 2010; Jappe et al., 2011; Matton et al., 2015). Together, the available evidence seems to converge to the conclusion that there is no straightforward relationship between SR and EDs. A partial explanation might be that the SOT uses a form of reward that is not ED specific: the cues, the target and the reward have no meaningful association with EDs. It is possible that the results would be different when stimuli would be used that are relevant in the context of an ED, for example cues predicting reward in the domain of food and weight or cues predicting social reward (Cardi, Di Matteo, Corfield, & Treasure, 2013). This is also in line with a more recent perspective in the field of reinforcement sensitivity and EDs, suggesting that patients with an ED are not more or less sensitive for reward per se but that there is a change in the nature of the stimuli that are experienced as rewarding (Keating, Tilbrook, Rossell, Enticott & Fitzgerald, 2012). This means that examining attentional bias for cues predicting different types of reward might be an important goal in future research to test whether different results are obtained depending on the nature of the reward.

Secondly, regarding SP, it was found that patients with a binge/purge ED showed more difficulty to redirect their attention away from cues predicting punishment than patients with AN-R. This difference was only evident for the long delay trials, and thus seems to imply some top-down voluntary control. This may be due to a more general difference in effortful control between restrictive and binge/purge EDs. More specifically, patients with a restrictive ED without binge/purge episodes have been found to show higher levels of effortful control than patients with a binge/purge ED (Claes, Mitchell, & Vandereycken, 2012). For the short delay trials, especially the reactive traits of SR and SP might determine individuals' pattern of responding, while for long delay trials, the level of effortful control might play an additional role. This might explain why specifically for long delay trials patients with AN-R experienced less difficulty to disengage their attention from places of expected punishment than patients with a binge/purge ED.

In addition, it was found that patients with an ED tended to show an enhanced sensitivity for cues predicting punishment compared to non-symptomatic controls. This supports the hypothesis of heightened SP in patients with an ED compared to controls, regardless of the specific ED type, and is consistent with previous results showing heightened SP in patients with an ED based on self-report instruments (Harrison et al., 2010; Matton et al., 2015). This potentially higher sensitivity for cues predicting punishment in patients with an ED is also in line with earlier research using punishments that are specifically meaningful within the context of an ED. For example, sensitivity for cues predicting punishment in social interactions, such as social rejection, is found to be higher in patients with an ED compared to controls (Cardi, et al., 2013). These findings may help explain how attentional bias for cues predicting punishment could play a role in EDs. More specifically, since enhanced sensitivity for cues predicting punishment seems to be present in social situations as well, this might contribute to the lack of control that is often experienced by patients with an ED in social situations (Sternheim, Konstantellou, Startup, & Schmidt, 2010). Their ED might in part be a way to compensate that lack of control by (an attempt to) control their eating behaviour (Zucker, Losh, Bulik, LaBar, Piven, & Pelphrey, 2007). Moreover, high SP in general has been found to be associated with more avoidant behaviour towards specific food stimuli in children (Vandeweghe, Vervoort, Verbeken, Moens, & Braet, 2016). Perhaps, then, heightened attention for signals of punishment may also be involved in this type of avoidance responses that are typically observed in patients with an ED.

Taken together, the present findings are partly in line with the hypothesis that heightened SP may be involved in EDs, and cast further doubts on the role of SR within the context of EDs. Although the SOT has been used in the domain of substance abuse before (van Hemel-Ruiter et al., 2013) and parallels have often been drawn between EDs and substance abuse (Dawe & Loxton, 2004; Hodgins, von Ranson, & Montpetit, 2015), the present findings suggest that there are also important differences between addiction and EDs with regard to the attentional processes involved. Whereas attentional bias towards signals predicting reward has been found to be positively associated with substance abuse (van Hemel-Ruiter et al., 2013), it seems that especially attentional bias towards signals predicting punishment might be positively associated with disordered eating. This is in line with previous results indicating that different motives are involved in alcohol use compared to motives underlying disordered eating (Hodgins, et al., 2015).

This study has several strengths. By using the SOT as a measure of individuals' sensitivity for cues predicting reward/punishment, the current study was able to provide important information about mechanisms of information processing in patients with an ED. This complements previous studies that focused on experienced affect in response to actual reward/punishment. In addition, since SR is assumed to be involved in binge eating (Schag, et al., 2013), differences between AN-R and AN-B/P patients regarding SR may be masked when including both ED types into one category. Therefore, in the present study, patients with a purely restrictive ED were compared with patients with a binge/purge ED.

However, it is also important to note several limitations of the present study and the related suggestions for future research. First, the current work represents the first study using the SOT in a clinical sample of patients with EDs. Several concerns regarding the task design warrant further research on the usability of the SOT in EDs. Some important issues here that require further exploration are for example the lack of a general disengagement effect and possible age effects. First, the general pattern of heightened engagement towards cues predicting reward (or nonpunishment) was not completely paralleled by a heightened difficulty to disengage from cues predicting reward (or nonpunishment). This means that the results on the disengagement trials should be interpreted with caution since it is not clear whether the task performed as expected in these trials. Previous research also failed to confirm this disengagement effect in short delay trials, but did find this effect in the long delay trials (Van Hemel-Ruiter et al., 2013), which is similar to the present results. Further research exploring possible methodological issues explaining this lack of a disengagement effect seems necessary. Regarding the effect of age, it might be necessary to compare the performance on the SOT between adolescents and adults. Although the present results revealed no correlation between the participants' age and the SOT outcomes, it should be kept in mind that SR has been shown to be increased during adolescence (Galvan, 2013), which could have influenced the results on the SOT. In addition, the sample sizes were small and as such it seems useful to assess the SOT in larger samples, to test the hypotheses with more statistical power. In the current study, the small size may have obscured some effects, such as the age effect. Future research on this task might also want to test the correlations of the SOT with self-report measures of SR and SP and with other performance based measures, such as for example the card-sorting task previously used by Loxton and Dawe (2007). Finally, it should also be kept in mind that the reward and punishment used in the SOT was artificial in the sense that only points were added or subtracted. How this might influence the results might be an important research topic as well, for example by comparing these results with the results when using more concrete forms of reward or punishment, such as real gadgets that can be won or lost.

On top of these concerns regarding the SOT, some additional limitations should be noted. First, no patients with BED were recruited for the study. It will be important to include this diagnostic category in future research to get a more comprehensive understanding of the way SR and SP are involved in EDs. A second limitation concerns the fact that participants within the control sample were only assessed for the current presence of an ED and not for a lifetime diagnosis of an ED. It might be important for future research to take this into account. Finally, the inclusion of both adolescents and young adults can be considered both a strength and a limitation, since more research in adolescents seems necessary given the incidence and prevalence rates for EDs in this age group (Hoek & Van Hoeken, 2003), but at the same time age might have had an effect on concentration and on SR (Galvan, 2013), thereby influencing the results. As previously mentioned, this hypothesis was not supported by the correlational analyses, but warrants further research given the small sample sizes in the present study.

It should also be acknowledged that the cross-sectional design of the present study does not allow any firm conclusions regarding the direction of the relationship between attentional bias and disordered eating. Therefore, it is important for future research to test the proposed relationship in a longitudinal design. This would give the opportunity to test whether attentional bias for cues signalling punishment indeed has predictive value for future ED problems (e.g., Jonker, Glashouwer, Ostafin, van Hemel-Ruiter, Smink, Hoek, & de Jong, 2016). To more directly examine the alleged causal role of attentional bias for punishment in the persistence of symptoms, it would be critical to bring attentional bias under experimental control. Previous research in the context of eating behaviour has shown that domain-specific attentional biases can be successfully reduced following an attentional bias modification procedure, and can result in meaningful reduction of ED symptoms (Kemps, Tiggeman, Orr, & Grear, 2014; Smith & Rieger, 2009). It would be interesting to see whether a similar attention bias modification procedure applied to attentional bias for cues predicting punishment would similarly result in a reduction of ED symptoms. This would not only be relevant to test the role of attentional bias for cues predicting punishment in the persistence of ED symptoms, but may also provide theory derived starting points for new clinical interventions.

To conclude, the present findings did not provide consistent evidence to indicate that patients with ED show a differential attentional bias towards (or away from) rewards. However, patients with an ED did show a heightened attentional bias for signals of punishment, and this heightened attentional bias for punishment seemed most consistent for patients with a binge/purge ED. Together the findings not only support the view that heightened SP is involved in EDs, but also show that the SOT is sensitive for individual differences in SP/SR within the context of EDs, thereby sustaining its usefulness as a behavioural measure of reinforcement sensitivity.

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Tables

Table 1. Calculation of the SOT-variables.

	positive games	negative games
short delay (250ms)	reward engagement = RT cued red trials – RT cued blue trials	punishment engagement = RT cued blue trials – RT cued red trials
	reward disengagement = RT uncued blue trials – RT uncued red trials	punishment disengagement = RT uncued red trials – RT uncued blue trials
long delay (500ms)	reward engagement = RT cued red trials – RT cued blue trials	punishment engagement = RT cued blue trials – RT cued red trials
	reward disengagement = RT uncued blue trials – RT uncued red trials	punishment disengagement = RT uncued red trials – RT uncued blue trials

Note. RT = Reaction Time, cued red trials = hard trials, cued blue trials = easy trials, uncued blue trials = hard trials, uncued red trials = easy trials

Table 2. Results of the paired samples t-tests.

		M(SD)	t(df)
short delay	reward engagement	23.21(34.23)	5.25(59)***
	reward disengagement	-10.25(55.24)	-1.44(59)
long delay	reward engagement	18.82(42.27)	3.45(59)**
	reward disengagement	-15.28(57.19)	-2.07(59)*
short delay	punishment engagement	-17.03(29.83)	-4.42(59)***
	punishment disengagement	3.99(53.01)	.58(58)
long delay	punishment engagement	-14.61(35.78)	-3.16(59)**
	punishment disengagement	-2.68(56.67)	-.37(59)

*Note. M = Mean, SD = Standard Deviation; engagement refers to comparisons between cued blue versus cued red trials; disengagement refers to comparisons between uncued blue versus uncued red trials; *p<.05, **p<.01, ***p<.001*

Table 3. Pearson correlations between age, self-reported illness duration and the SOT-variables.

	age	self-reported illness duration
short delay reward engagement	-.18	-.14
short delay reward disengagement	.12	.11
long delay reward engagement	-.04	-.24
long delay reward disengagement	-.02	-.01
short delay punishment engagement	-.05	-.27
short delay punishment disengagement	-.08	-.04
long delay punishment engagement	.08	-.14
long delay punishment disengagement	.05	.02

Note. **p<.05, **p<.01, ***p<.001*

Table 4. Mean scores on the SOT-variables for the control group, patients with AN-R and patients with a binge/purge ED.

		control sample (n=23)	**AN-R (n=20)**	**Binge/Purge ED (n=16)**
		M(SD)	M(SD)	M(SD)
short delay	reward engagement	32.09(49.45)	16.41(14.18)	22.34(19.72)
	reward disengagement	-24.26(70.73)	3.46(43.39)	-10.45(39.39)
long delay	reward engagement	29.12(43.96)	9.14(38.12)	19.83(42.77)
	reward disengagement	-20.43(41.13)	9.81(41.55)	-21.14(41.06)
short delay	punishment engagement	-26.18(33.19)	-6.95(19.88)	-18.23(32.61)
	punishment disengagement	2.06(66.41)	.28(34.30)	11.42(53.16)
long delay	punishment engagement	-26.80(45.30)	-5.63(25.78)	-10.01(27.85)
	punishment disengagement	-12.83(67.41)	-13.34(48.77)	27.84(39.18)

Note. AN-R = Anorexia Nervosa – Restrictive type, ED = Eating Disorder, M = Mean, SD = Standard Deviation; Binge/Purge ED comprises patients with Anorexia Nervosa – Binge/Purge type and Bulimia Nervosa

Table 5. Results of the Manova testing the association between diagnosis and SOT outcomes and the linear and quadratic contrast effects.

		diagnosis					
		F(2)	η^2	linear contrast estimate	95% coincidence interval	quadratic contrast estimate	95% coincidence interval
short delay	reward engagement	1.19	.04	-6.89	-22.41; 8.63	8.82	-6.41; 24.05
	reward disengagement	1.36	.05	9.77	-15.58; 35.11	-17.00	-41.86; 7.86
long delay	reward engagement	1.23	.04	-6.57	-25.81; 12.68	12.52	-6.37; 31.40
	reward disengagement	3.62*	.12	-.50	-19.53; 18.52	-24.98*	-43.64; -6.32
short delay	punishment engagement	2.33^+	.08	5.62	-7.83; 19.08	-12.46^+	-25.66; .75
	punishment disengagement	.22	.01	6.62	-18.17; 31.40	5.28	-19.04; 29.59
long delay	punishment engagement	2.16	.07	11.88	-4.36; 28.11	-10.43	-26.36; 5.49
	punishment disengagement	3.25*	.10	28.76*	3.49; 54.03	17.02	-7.77; 41.81

*$p<.05$, **$p<.01$, ***$p<.001$, $^+p=.06$*

Table 6. Results of the one-way Anova contrast tests.

		contrast value (SE)	t (df)
short delay reward engagement	control vs. ED	-28.56(21.60)	-1.32(26.27)
	AN-R vs. binge/purge ED	2.79(6.43)	.44(25.70)
short delay reward disengagement	control vs. ED	44.57(29.18)	1.53(57)
	AN-R vs. binge/purge ED	-10.89(18.10)	-.60(57)
long delay reward engagement	control vs. ED	-32.82(22.38)	-1.47(57)
	AN-R vs. binge/purge ED	7.13(13.89)	.51(57)
long delay reward disengagement	control vs. ED	12.83(29.14)	.44(57)
	AN-R vs. binge/purge ED	-47.65(18.08)	-2.64(57)*
short delay punishment engagement	control vs. ED	28.92(15.51)	1.86(57)+
	AN-R vs. binge/purge ED	-9.55(9.62)	-.99(57)
short delay punishment disengagement	control vs. ED	7.58(28.76)	.26(56)
	AN-R vs. binge/purge ED	11.14(18.03)	.62(56)
long delay punishment engagement	control vs. ED	39.28(18.62)	2.1(57)*
	AN-R vs. binge/purge ED	-3.07(11.55)	-.27(57)
long delay punishment disengagement	control vs. ED	35.91(29.30)	1.23(57)
	AN-R vs. binge/purge ED	-36.94(18.18)	-2.03(57)*

Note. SE = Standard Error, ED = Eating Disorder, AN-R = Anorexia Nervosa – Restrictive type, binge/purge ED = patients with a diagnosis of Anorexia Nervosa – Binge/purge type or Bulimia Nervosa; $^{*}p<.05$, $^{**}p<.01$, $^{***}p<.001$, $^{+}p<.07$

Figures

Figure 1. Vertical bars at possible cue and target location with the participant's score.

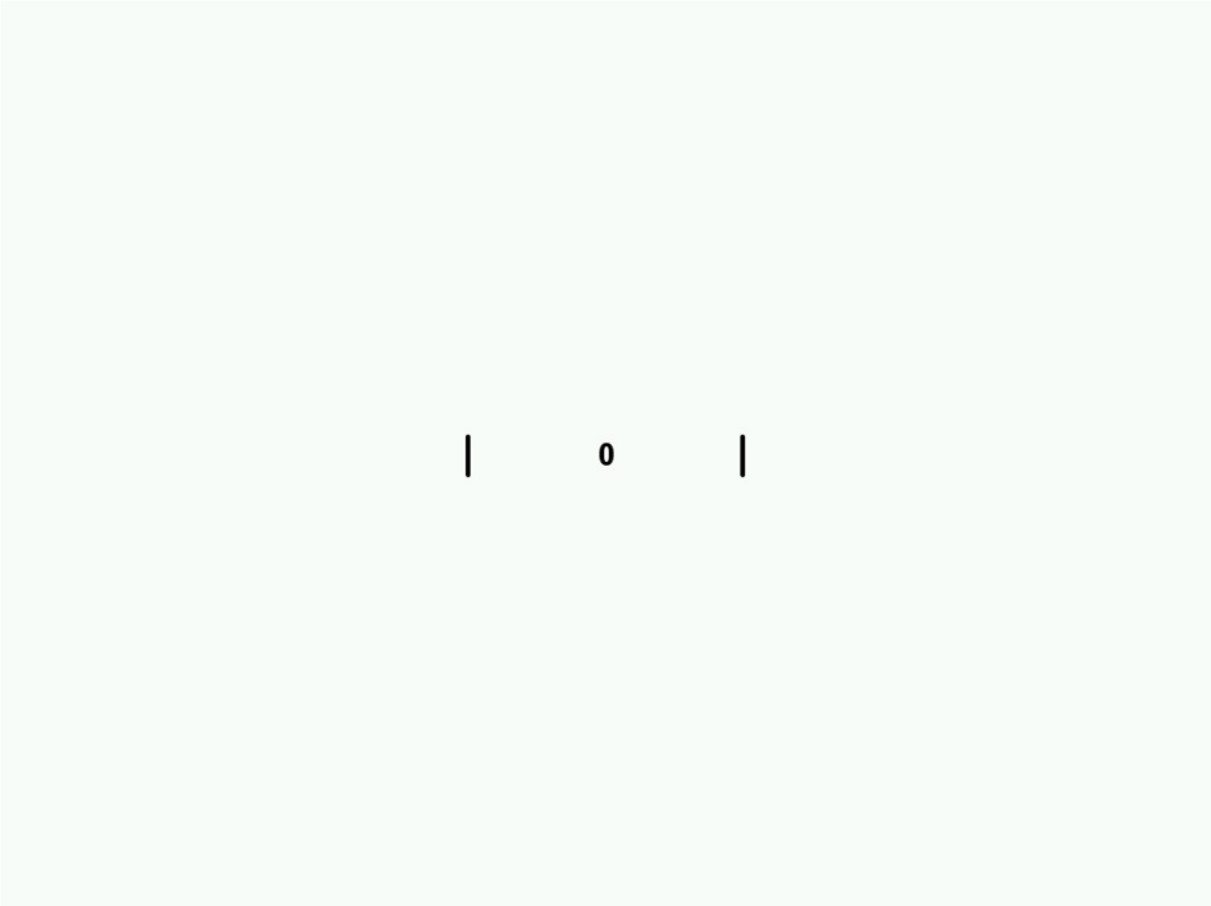


Figure 2. Cue predicting reward or non-punishment.

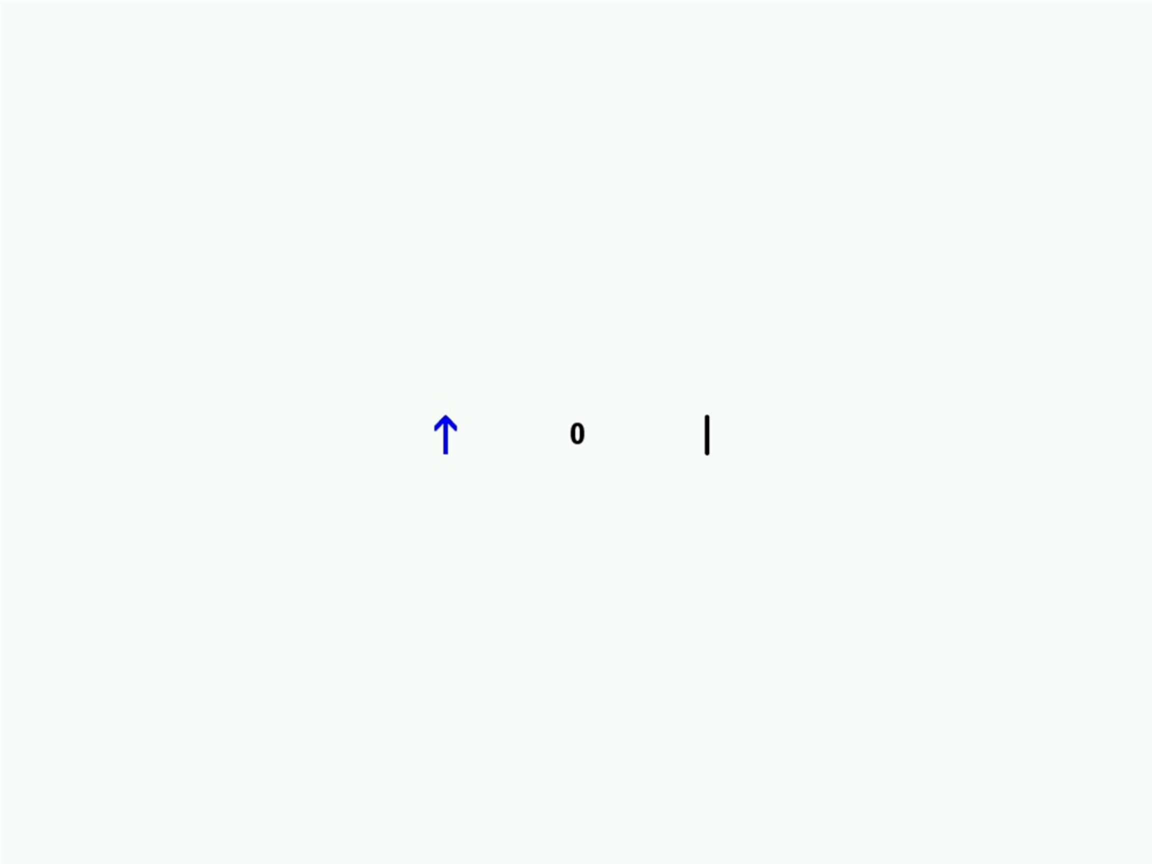


Figure 3. Cue predicting punishment or non-reward.

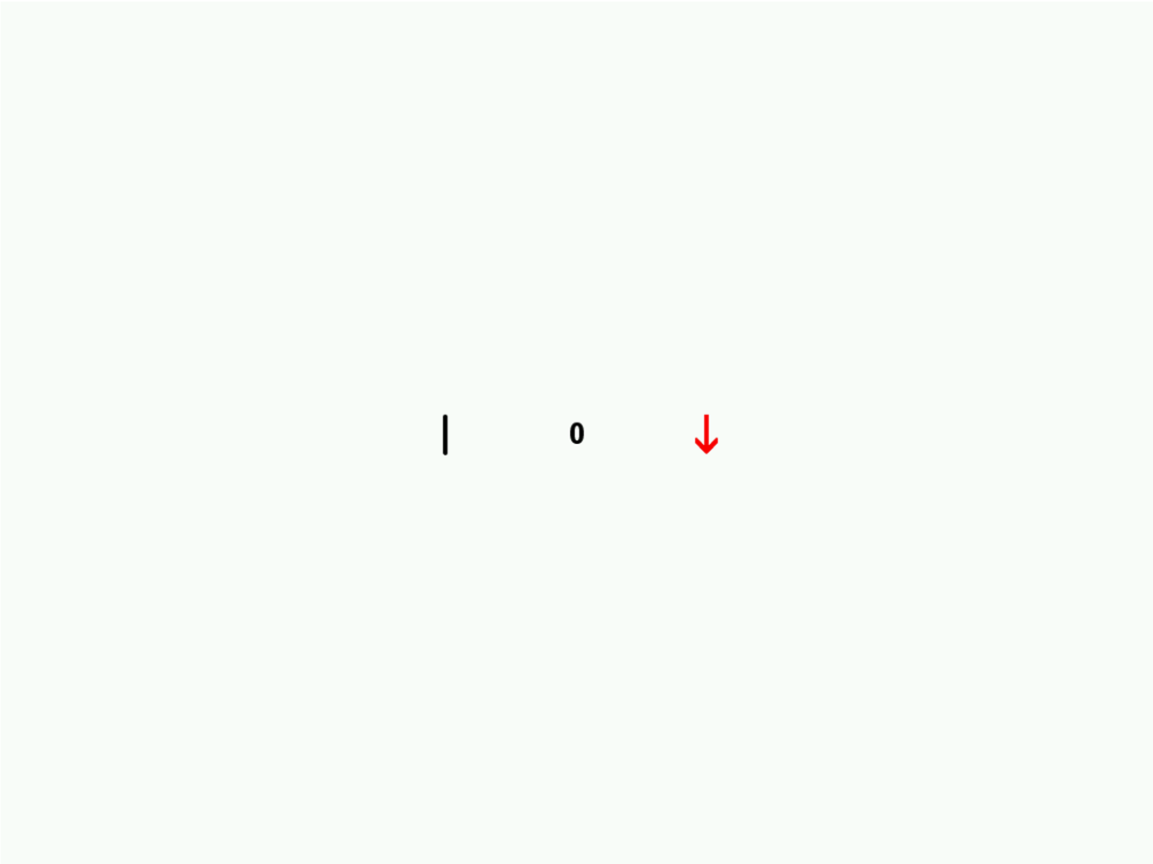


Figure 4. Cued trial.

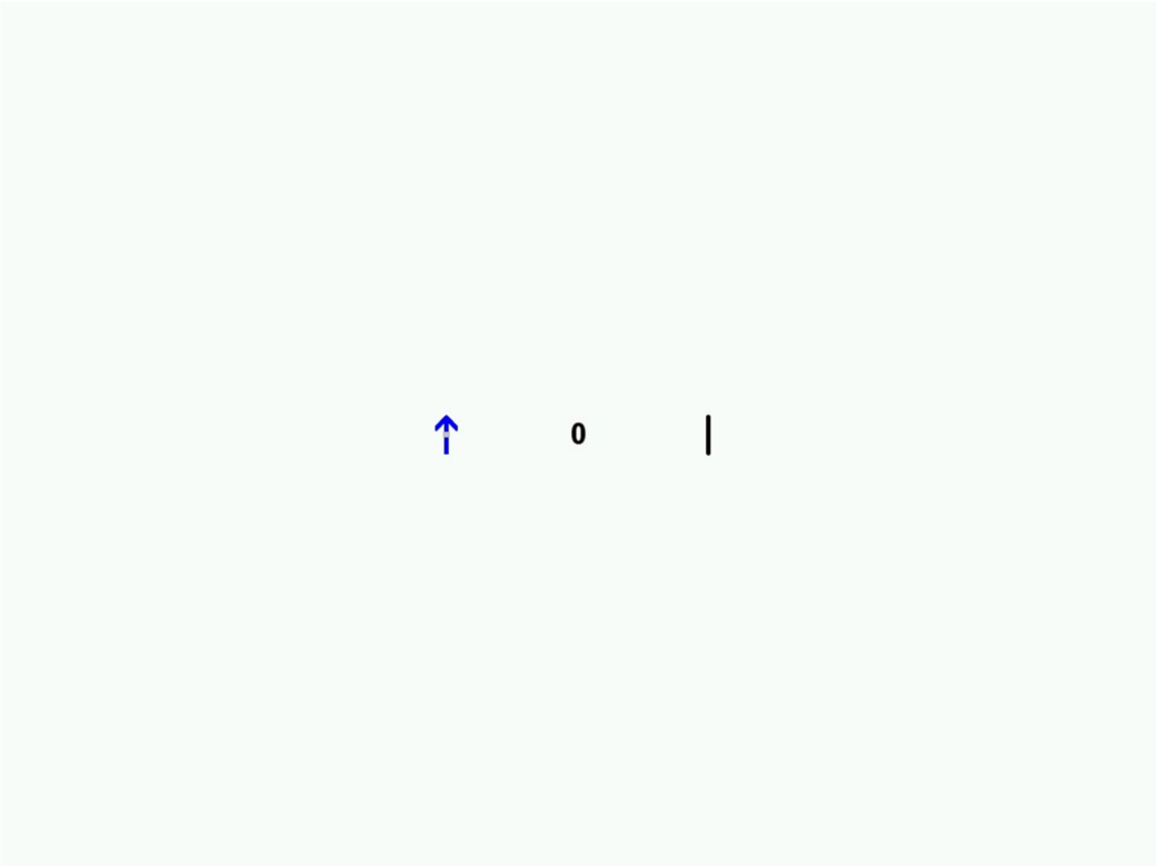


Figure 5. Uncued trial.

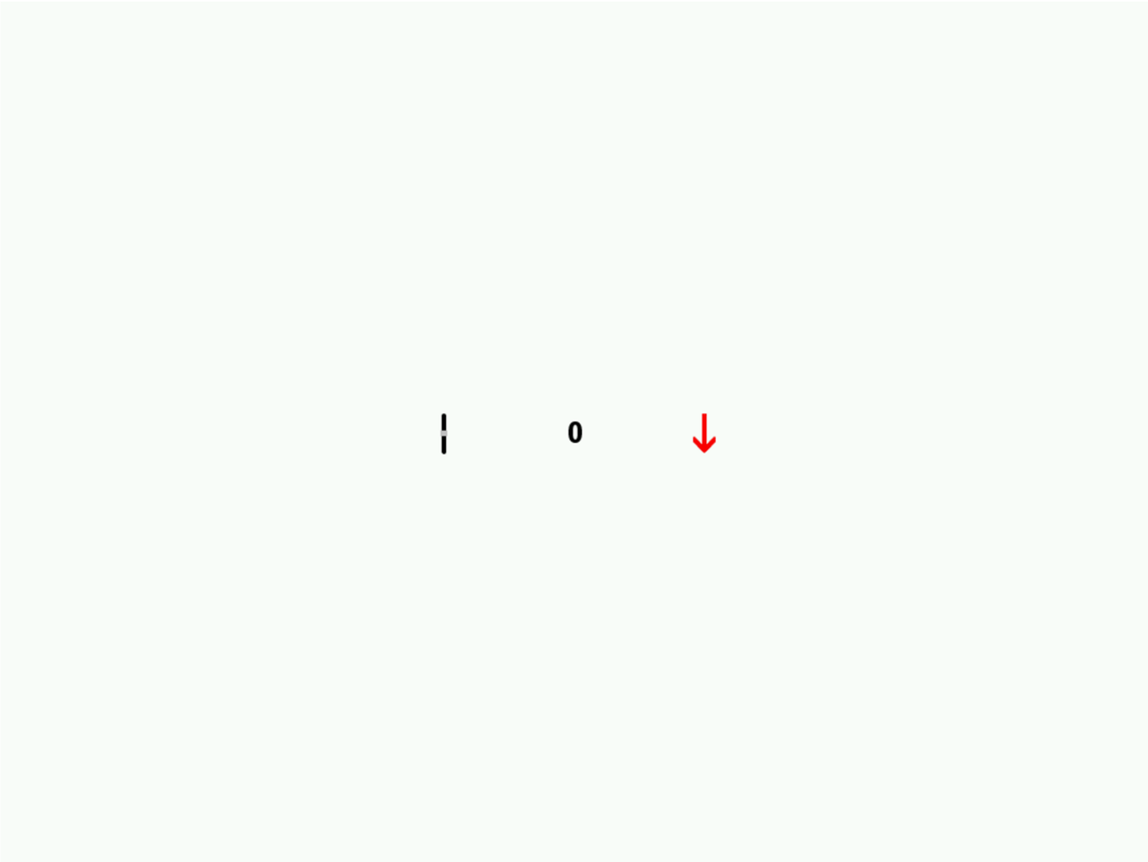
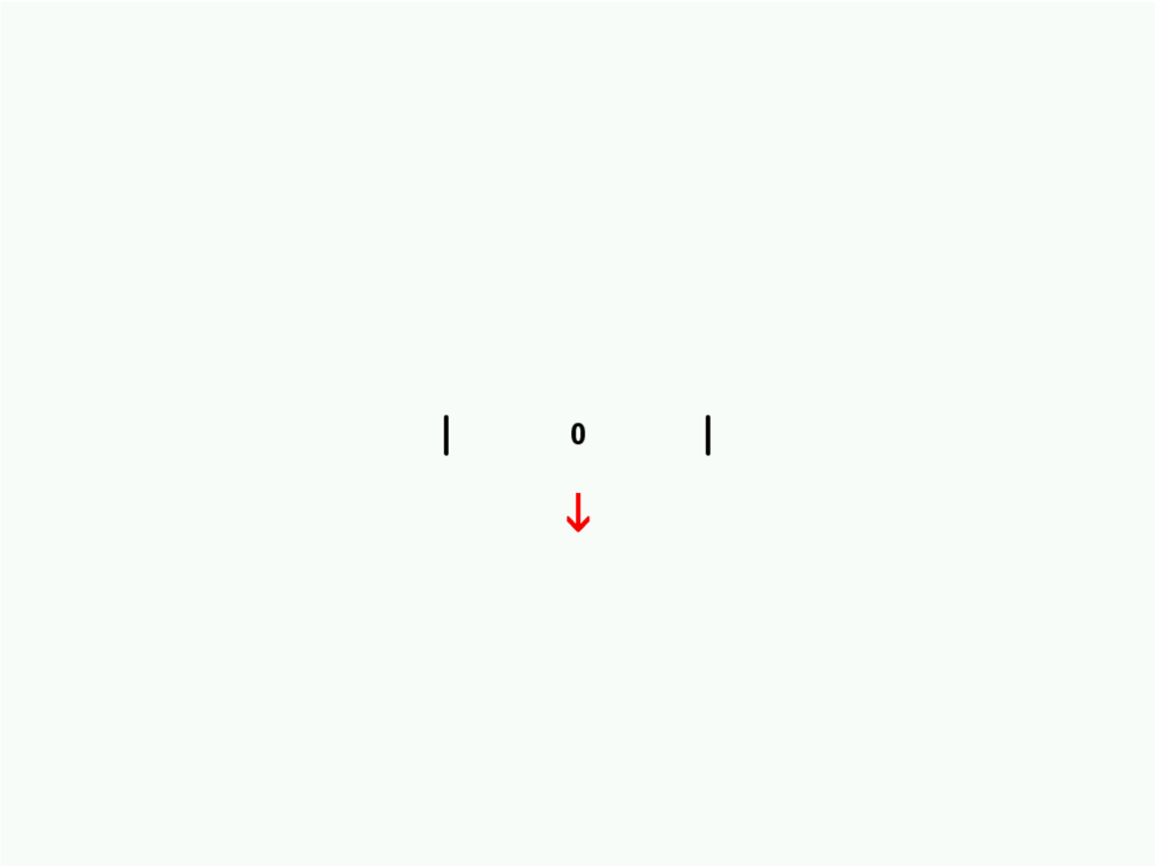


Figure 6. Positive feedback signal.

Figure 7. Negative feedback signal.



Chapter 4

Punishment and reward sensitivity: are naturally occurring clusters in these traits related to eating and weight problems in adolescents?[3]

Abstract

Little is known about the role of Sensitivity to Punishment (SP) and Reward (SR) in eating problems during adolescence. Therefore, the aim of the present study was to examine the naturally occurring clusters of high and low SP and SR among nonclinical adolescents and the between-cluster differences in various eating problems and weight.

A total of 579 adolescents (14–19 years, 39.8% boys) completed the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ), the Behavioural Inhibition System and Behavioural Activation System scales (BIS/BAS scales), the Dutch Eating Behaviour Questionnaire and the Child Eating Disorder Examination Questionnaire and were weighed and measured.

On the basis of the SPSRQ, four clusters were established, interpreted as lowSPlowSR, lowSPhighSR, highSPhighSR and highSPlowSR. These were associated with eating problems but not with adjusted body mass index. It seemed that specifically the highSPhighSR cluster outscored the other clusters on eating problems. These results were partly replicated with the

[3] Matton, A., Goossens, L., Braet, C., & Vervaet, M. (2012). Punishment and Reward Sensitivity: Are Naturally Occurring Clusters in these Traits Related to Eating and Weight Problems in Adolescents? *European Eating Disorders Review*, *21*, 184-194. doi: 10.1002/erv.2226.

BIS/BAS scales, although less significant relations between the clusters and eating problems were found.

The implications of the findings in terms of possible risk and protective clusters are discussed.

Introduction

The role of sensitivity to punishment (SP) and sensitivity to reward (SR) in the aetiology of eating disorders receives increasing attention in current scientific research (e.g. Harrison, O'Brien, Lopez & Treasure, 2010; Harrison, Treasure & Smillie, 2011). Although until now the exact relation between these temperament traits and eating behaviour remains unclear, the existing data on this topic suggest that individual differences in SR and SP may be fundamental in understanding individual reactions to food and as such emphasize the need to gain better insight in the role of SR and SP in eating problems and eating disorders (Harrison et al., 2010; Harrison et al., 2011).

Eating disorders, such as Anorexia Nervosa of the Restricting type (AN-R), Anorexia Nervosa of the Binge/Purge type (AN-B/P), Bulimia Nervosa (BN) and Eating Disorder Not Otherwise Recognized (EDNOS), including Binge Eating Disorder (BED), are severe conditions with consequences on both a psychosocial and physical level (Brunner & Resch, 2006). According to the criteria of the Diagnostic and Statistical Manual of Mental Disorders (4th edition, text rev. (DSM-IV-TR); American Psychiatric Association (APA), 2000) AN is characterized by restrictive eating, combined with binge eating and purging behaviour in the case of AN-B/P, and an intense fear or unwillingness to gain weight whereas in reality the person has underweight or very low weight. BN and BED are both characterized by episodes of binge eating, but BN-patients show compensatory behaviour, which is absent in BED (APA, 2000). Moreover, all categories share the high weight and shape concerns, often seen as the core psychopathology of eating disorders (APA, 2000; Fairburn, Cooper & Shafran, 2003).

Importantly, adolescence seems to be a period of heightened risk to develop an eating disorder (Hoek & Van Hoeken, 2003; Swanson, Crow, Le Grange, Swendsen & Merikangas, 2011; Waaddegaard, Davidsen, & KjØller, 2009), with eating problems seen as possible precursors of full-blown eating disorders (Field, Camargo, Taylor, Berkey, Roberts & Colditz, 2001; Stice, 2002). As a consequence, different factors have already been established as risk factors, such as body changes during puberty, high perfectionism, high environmental pressure to be thin and low self-esteem (Boone, Soenens & Braet, 2011; de Santana, Ribeiro, Giral & Raich, 2012). However, recently, the temperament traits SP and SR are receiving increasing attention regarding their possible fundamental role in eating disorders and eating problems as well (e.g. Bijttebier, Beck, Claes, & Vandereycken, 2009; Harrison et al., 2010; Harrison et al., 2011).

The concepts of SP and SR are linked to Gray's Reinforcement Sensitivity Theory (RST; Gray, 1970, 1982, 1987; Gray & McNaughton, 2000), a biologically based model of motivational behaviour, closely related to personality (Mardaga & Hansenne, 2007; Smillie, Pickering & Jackson, 2006). In its original version this theory postulates that behaviour is governed by three biological systems, namely the Behavioural Activation System (BAS), the Behavioural Inhibition System (BIS) and the Fight-Flight System (FFS). The BAS is originally thought to be activated in response to conditioned appealing stimuli and to lead to approach behaviour. The BIS is hypothesized to respond to signals of punishment, frustrating non-reward and novelty and to inhibit ongoing behaviour. The FFS is postulated to respond to the presence of unconditioned aversive stimuli and to lead to defensive aggression (fight) or escape behaviour (flight) (Gray, 1970, 1982, 1987). The concepts of SR and SP fit nicely into this theory, reflecting the sensitivity of the BAS and the BIS respectively. Additionally, all combinations of high and low SR and SP are thought to occur, as the RST posits that the BAS and the BIS can be activated independently from each other (Gray, 1970, 1982, 1987).

However, in 2000 Gray and McNaughton revised the original RST, which led to some important conceptual changes. First, the distinction between conditioned and unconditioned stimuli disappeared and consequently the BAS is now assumed to mediate responses to all appetitive stimuli (Gray & McNaughton, 2000). A similar change was made concerning the FFS, now called the Fight-Flight-Freeze-System (FFFS) and thought to be responsible for all reactions to aversive stimuli, both conditioned and unconditioned, leading to aggressive behaviour and fear (Gray & McNaughton, 2000). The BIS is now assumed to inhibit all ongoing behaviour, regardless of its appetitive or aversive nature, whenever conflicts arise due to competing motivational objectives. As such, the BIS is no longer a pure punishment system, but rather serves conflict detection and resolution (Smillie et al., 2006). These changes in the conceptualization of the RST have important implications for our understanding of SR and SP. More specifically, SR can still be considered to reflect the responsiveness of the BAS, though the link between SP and the BIS seems to be replaced by a link between SP and the sensitivity of the FFFS. Nevertheless, the distinction between the BIS and the FFFS appears to be very hard to make using self-report questionnaires (Matton, Goossens, Braet & Vervaet, submitted; Smillie et al., 2006) and although the FFFS is defined as a pure punishment system, the BIS is activated by conflict, which can be seen as a negative event or punishment as well. Therefore, it seems reasonable to assume that the more broader concept of SP reflects both BIS- and FFFS- sensitivity, as noted before by Harrison et al. (2010).

Evidence for the possible important role of the traits of SP and SR in eating behaviour comes from both the eating disorder and the obesity domain. More specifically, within the eating disorder field, a review conducted by Harrison et al. (2010) showed that, in general, eating disorder patients with AN-R had lower SR compared to healthy controls, whereas patients with AN-

B/P and patients with BN had higher SR than the control group. Moreover, all three diagnoses were related to higher SP when compared to healthy controls.

Nevertheless, Harrison et al. (2010) reported high degrees of inconsistency between different studies concerning all significant effects found. Moreover, most of the studies reviewed by Harrison et al. (2010) used measures of SR and SP based on other personality models than the RST, such as Cloninger’s model of personality (Cloninger, 1987; Cloninger, Svrakic & Przybeck, 1993). In fact, the two most frequently used instruments that are directly based on the RST are the BIS/BAS scales (Carver & White, 1994) and the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ; Torrubia, Avila, Molto & Caseras, 2001). The BIS/BAS scales discriminate between one BIS and three BAS subscales, namely BAS-Drive, BAS-Fun Seeking and BAS-Reward Responsiveness. BAS-Drive is defined as the persistent pursuit of desired goals, BAS-Fun Seeking as the desire for new rewards and a willingness to approach potentially rewarding events on the spur of the moment, and BAS-Reward Responsiveness as positive responses to the occurrence or anticipation of reward (Carver & White, 1994). However, debate concerning the item content of this questionnaire, which is related to generalized SP and SR, whereas the RST deals with specific cues of punishment and reward (Matthews & Gilliland, 1999; Torrubia et al., 2001; Zinbarg & Revelle, 1989), led to the development of the SPSRQ (Torrubia et al., 2001), discriminating between one SP and one SR subscale.

Although both these instruments are directly derived from the RST, the review of Harrison et al. (2010) shows that most studies use the Tridimensional Personality Questionnaire (TPQ; Cloninger, 1978) or the Temperament and Character Inventory (TCI; Cloninger et al., 1993) to operationalize SP and SR (e.g. Harrison et al., 2010), based on Cloninger’s model of personality (Cloninger, 1987; Cloninger et al., 1993). These instruments measure several temperament traits, namely Harm Avoidance (HA), Novelty Seeking (NS) and Reward Dependence (RD) in case of the TPQ, and the additional trait of Persistence (P) in the TCI (Cloninger, 1987; Cloninger et al., 1993). Although there is a considerable overlap between the RST and Cloninger’s model of personality, with SP being related to HA and SR to NS, instruments based on them do not measure exactly the same and are as such not interchangeable (Dawe & Loxton, 2004; Matton et al., submitted). For example, it has been shown that SP, tapped via the BIS scale of the BIS/BAS scales, is not only related to HA but to RD as well in non-clinical adolescents (Matton et al., submitted). As such, this mixed use of instruments to measure SP and SR has possibly contributed to the inconsistency in results (e.g. Harrison et al., 2010).

It should also be noted that most of the studies included in the review of Harrison et al. (2010) were based on adult data, with only two out of the twenty-five studies focusing on adolescents with an eating disorder (Bloks, Hoek, Callewaert & van Furth, 2004; Rybakowski, Slopien, Zakrzweska, Hornowska & Rajewski, 2004). In this specific population, the previously described findings were confirmed as well, but unfortunately, no pure RST-measures were used (Bloks et al., 2004; Rybakowski et al., 2004).

Also in non-clinical samples, relations between SP and SR on the one hand and eating problems on the other hand have been found repeatedly. For example, a review by Bijttebier et al. (2009) reports associations between both heightened SP and heightened SR and dysfunctional eating in undergraduates (Loxton & Dawe, 2001, 2004, 2006). Nevertheless, the fact that most of these results were based on studies with female college students limits the generalizability of these findings.

Within the obesity domain, the association between SR and weight has recently drawn the attention of many researchers as well. This has led to the hyper-responsive hypothesis, positing that high SR leads to overeating and as such to overweight, because the rewarding value of food is higher for those individuals compared to people with lower SR (Davis, Strachan & Berkson, 2004; Dawe & Loxton, 2004; Franken & Muris, 2005). This hypothesis has been frequently confirmed in overweight samples. For example, results from a review conducted by Stice, Spoor, Ng and Zald (2009) indicated that, based on self-report and behavioural data, obese people show elevated anticipatory and consummatory food reward compared to lean individuals. Also in line with this positive association between SR, overeating and weight, Davis et al. (2004) found SR to correlate positively with both emotional overeating and weight in a sample of healthy adult women. However, neither of both studies included measures of SP, although this might be important since SR and SP might interact with each other in influencing behaviour (Corr, 2001; Gray, 1970, 1982, 1987).

Summarized, although several research findings clearly indicate that SP and SR matter in eating behaviour, the exact role of these temperament factors remains unclear because of inconsistent operationalization and different study populations, with a majority of adult females and a minority of males and adolescents (e.g. Claes, Robinson, Muehlenkamp, Vandereycken & Bijttebier, 2010; Harrison et al., 2011). Moreover, most studies focus solely on the role of SR, especially within the obesity domain (e;g. Davis et al., 2004; Stice et al., 2009). Therefore, the aim of the current study was to examine the role of SR and SP in a variety of eating- and weight- related problems based on a sample of non-clinical adolescent boys and girls.

The first goal was to establish the naturally occurring clusters of SP and SR in this group. Based on the assumption that the BIS and the BAS are independent but interacting biological systems (Corr, 2001; Gray, 1970, 1982, 1987; Mardaga & Hansenne, 2007), it was expected that four clusters of high and low SP and SR would be found, namely high SP combined with high SR, low SP combined with low SR, high SP combined with low SR, and low SP combined with high SR.

The second goal was to examine the differences in eating problems and weight between these clusters. It was expected that higher scores on emotional eating would be associated with the cluster of high SP combined with high SR, following the results of Harrison et al. (2010) indicating that BN-patients had both heightened scores on SP and SR and appear to show more emotional eating through their binges. External eating on the other hand was expected to occur mostly in clusters with high SR, as evidence has already been found for a hyper-responsive syndrome (e.g. Davis et al., 2004; Stice et al., 2009). It was also hypothesized that restrictive eating would be most strongly associated with the cluster of high SP combined with low SR (Harrison et al., 2010). Concerns about eating, body shape and weight were also expected to be highest in the high SP combined with low SR cluster, as this is regarded as the most vulnerable cluster to develop an ED (Harrison et al., 2011). Regarding weight, the cluster of high SP and low SR was expected to be associated with lower weight, whereas, based on the results of Davis et al. (2004), higher weight was expected in the high SR clusters.

Material and Methods

Participants and Procedure

Nine Flemish secondary schools were contacted and agreed to participate in the current study. This resulted in a sample of 579 pupils (39.8% boys) between the age of 14 and 19 years (M=15.72 years, SD=1.38).

All principals received information about the goal and design of the study and completed active informed consents. Parents received passive informed consents via the school, informing them about the study and asking them to indicate on the form if they did not want their child to participate.

The completion of the questionnaires took place during school hours in the presence of a researcher and a teacher. The participants completed active informed consents and were assured that all data would be handled confidentially. While they completed the questionnaires, they were also weighed and measured separately by the researcher outside the classroom. The total study took about one hour in each class. This procedure was approved by the university's ethic committee.

Materials

Sensitivity to Punishment and Reward. SP and SR were measured with the Dutch version of the SPSRQ (Torrubia et al., 2001) as our primary instrument and with the Dutch version of the BIS/BAS scales (Carver & White, 1994) as our secondary instrument for replication.

The SPSRQ (Torrubia et al., 2001) was developed to assess BIS- and BAS- functioning by a SP- and SR-subscale respectively (Torrubia et al., 2001) and consists of 44 items to be answered on a five point scale, ranging from 'never' to 'always'. Both the SP- and the SR- subscale consist of 22 items. It has been shown that both scales present satisfactory internal consistency and test-retest reliability as well as convergent and discriminant validity (Torrubia et al., 2001). The validity of the Dutch version has been shown to be comparable to the validity of the original version in eating disordered patients (Beck, Smits, Claes, Vandereycken & Bijttebier, 2009). Cronbach alphas in the current study were .87 for SP and .79 for SR.

The BIS/BAS scales (Carver & White, 1994) were developed to assess dispositional BIS- and BAS-sensitivities (Carver & White, 1994) and contain 24 items, including 4 distraction items, that are to be answered on a four point scale, ranging from 'totally disagree' to 'totally agree'. Two main subscales are distinguished, a BIS-scale (7 items) and a BAS-scale (13 items), with the BAS-scale being further divided into three lower-order subscales, namely

BAS-Drive (4 items), BAS-Fun Seeking (4 items) and BAS-Reward Responsiveness (5 items). The validity of the Dutch BIS/BAS scales has been proven to be sufficient (Franken, Muris, & Rassin, 2005), although this appears to be less the case in adolescents (Yu, Branje, Keijsers & Meeuws, 2011). Cronbach alphas in the present study were .76 for BIS, .73 for BAS, .67 for BAS-Drive, .55 for BAS-Fun Seeking and .57 for BAS-Reward Responsiveness.

Eating Problems. Both the Dutch Eating Behaviour Questionnaire (DEBQ; van Strien, Frijters, Bergers, & Defares, 1986) and the Dutch version of the Child Eating Disorder Examination Questionnaire (ChEDE-Q; Bryant-Waugh, Cooper, Taylor, & Lask, 1996) were included to measure eating styles and eating disorder symptoms.

The DEBQ (Van Strien et al., 1986) was developed to measure different eating styles and contains 33 items, divided into three subscales. We only included Emotional Eating (Emo) (13 items), or eating in response to negative emotions, and External Eating (Extern) (10 items), or eating in reaction to external triggers such as seeing or smelling food (Van Strien et al., 1986). The third scale, restrained eating, was excluded since this behaviour was measured via the Restraint-subscale from the ChEDE-Q. The items have to be answered on a five point scale, ranging from ‘never’ to ‘very often’. The DEBQ has high internal consistency and factorial validity (Van Strien et al., 1986). Cronbach alphas in the current study were .92 for Emo and .72 for Extern.

The ChEDE-Q (Bryant-Waugh et al., 1996) was developed to measure pathologic eating behaviour in children or adolescents and contains 23 items divided in four subscales, namely Restraint (Rest) (5 items), Concerns about Eating (ConEat) (5 items), Concerns about Body Shape (ConBody) (8 items) and Concerns about Weight (ConWeight) (5 items). All items consider the last four weeks and are to be answered on a seven point scale. The higher the score on the scale is, the greater the severity or presence of any given feature. The good validity of ChEDE-Q in Dutch adolescents has been shown repeatedly (e.g. Decaluwé & Braet, 2004; Goossens & Braet, 2010). Cronbach alphas for the ChEDE-Q in the current study were .87 for Rest, .78 for ConEat, .93 for ConBody and .87 for ConWeight.

Adjusted Body Mass Index (ABMI). Participants were weighed and measured by the researcher to obtain their ABMI. The Body Mass Index (BMI) as calculated for adults is thereby divided by percentile 50 (P50) of the BMI-scores of adolescents of the same age and gender as the subject. This number is subsequently multiplied by 100, resulting in the ABMI. The P50 is based upon Dutch grow-charts by Fredriks, van Buuren, Wit and Verloove-Vanhorick (2000). An ABMI score equal to or smaller than 85 is considered as underweight, a score equal to or greater than 120 as overweight, and a score equal to or greater than 140 as obese (Van Winckel & Van Mil, 2001). As such ABMI is comparable to z-BMI and used before by Matton, Goossens, Braet and Van Durme (2013), among others.

Data analytic plan

Since the SPSRQ (Torrubia et al., 2001) is a more recently developed instrument which answers to the shortcoming of the BIS/BAS scales (Carver & White, 1994) concerning item content and since this instrument also showed higher internal consistency in the present sample, the SPSRQ was our primary measure of SP and SR. The BIS/BAS scales (Carver & White, 1994) were used for replication of the SPSRQ-based results.

The SP- and SR-subscales of the SPSRQ were standardized and uni- and multivariate outliers were removed. Next, based on the recommendations by Gore (2000), cluster analysis was performed in two steps. In the first step, the standardized SP-and SR-scores were entered in a hierarchical cluster analysis. Secondly, a k-means cluster analysis was conducted to optimize the hierarchical solution. To derive the optimal number of clusters, we used the criterion that the cluster solution should explain at least 50% of the variance in each of the defining variables to be appropriate (Boone, Soenens, Braet & Goossens, 2010). Also interpretability, increases in explained variance, parsimony and the theoretical background of the RST were considered in defining the number of clusters.

After the establishment of the clusters, gender and age-differences between the clusters were examined using binary logistic regression and linear regression respectively. Next, a MANCOVA was conducted with Cluster as independent variable and Emo, Extern, Rest, ConEat, ConBody, ConWeight and ABMI as dependent variables. Gender was entered as a control variable. Post-hoc Tukey tests were performed to examine the nature of the differences in the dependent variables between the different clusters.

To replicate the findings within the same sample but with another instrument tapping SP and SR, this procedure was completely repeated with the BIS/BAS scales (Carver & White, 1994), with the BIS-scale measuring SP and the BAS-scale SR.

Results

Descriptives

The number of boys and girls scoring within the clinical range on the ChEDE-Q (Bryant-Waugh et al., 1996), namely having a mean score of 4 or more on Rest, ConEat, ConBody or ConWeight (Decaluwé & Braet, 1999), are presented in Table 1. There were no boys scoring 4 or more on all four variables simultaneously, but 5 girls (1.5%) did.

The mean ABMI was 106.14 (SD=16.37), ranging from 78.54 to 181.99. The frequency of underweight, normal weight, overweight and obesity is presented for boys and girls separately in Table 1.

The mean scores on all independent and dependent variables were compared between boys and girls, which revealed that there were significant gender differences in SP, SR, BIS, Emo, Rest, ConEat, ConBody, ConWeight but not in BAS, Extern or ABMI. The mean scores and t-values can be found in Table 2.

The correlations between all variables included in the study were calculated as well. The SP- and SR-subscales from the SPSRQ were significantly positively correlated with the BIS- and BAS subscales from the BIS/BAS scales respectively. The SP- and BIS-subscales were also significantly positively correlated with Emo, Rest, ConEat, ConBody and ConWeight, whereas the SR- and BAS-subscales were positively correlated with Extern. The SR-subscale was also significantly positively correlated with Emo and ConEat. All eating problems were positively intercorrelated. ABMI was negatively correlated with Extern and positively with Rest, ConEat, ConBody and ConWeight. All Pearson correlations can be found in Table 3.

Cluster Analysis With the SPSRQ

After standardization of the SP- and SR-scores, 3 univariate as well as 12 multivariate outliers were removed. Cluster solutions with two to five clusters were estimated via hierarchical cluster analysis. The two- and three-cluster solutions did not meet the cut-off of 50% explained variance in both SP and SR. Since both the four- and five-cluster solutions did meet this cut-off, we continued with these two solutions and performed k-means cluster analysis with both. The interpretability of the four- and the five-cluster solution was inspected, based on the z-scores of the clustering variables within each cluster. Although the z-scores were never extreme, the clusters within the four-cluster solution could be interpreted as a low SP combined with low SR cluster (lowSP x lowSR, $n=131$, $z=-.68$ and $z=-.97$ respectively), a low SP combined with high SR cluster (lowSP x highSR, n=109, z=-.93 and z=.49 respectively), a high SP combined with high SR cluster (highSP x highSR, n=105, z=.67 and z=1.05 respectively) and a high SP combined with a low SR cluster (highSP x lowSR, n=154, z=.75 and z=-.47 respectively). The five-cluster solution contained four similar clusters, but the fifth cluster was less clear, possibly reflecting a group scoring 'medium' on both SP and SR (mediumSP x mediumSR). This means that both cluster solutions were interpretable, though the five-cluster solution to a lesser extent.

Next, we compared the explained variances of both cluster solutions. The four-cluster solution explained 64% of the variance in SP and 70% of the variance in SR. The five-cluster solution explained 74% and 71% of the variance in SP and SR respectively. This means that, although the explained variance for SP was higher in the five-cluster solution, this difference was rather small for SR.

Finally, the theoretical expectations were considered, favouring the four-cluster solution over the five-cluster solution since the RST predicts that these four combinations of SP and SR should occur in the population (Gray, 1970, 1982, 1987), although the five-factor solution found here is not completely inconsistent with this hypothesis.

Taken together, the better interpretability of the four-cluster solution, the rather small difference in explained variance compared to the five-factor solution, the low additive value of the content of the fifth cluster, the expectations based on the RST, as well as the parsimony of the four-cluster solution all suggested that the four-factor solution was most appropriate. As such, this solution was chosen for further analyses.

Between-cluster Differences

Gender and Age. Binary logistic regression with Cluster as independent variable and Gender as dependent variable revealed significant gender-differences between the clusters, with $\chi^2(3)=31.92$, $p<.001$. There were more boys (32.0% of the boys) than girls (15.3% of the girls) in the lowSP x highSR cluster and more girls (36.9% of the girls) than boys (21.3% of the boys) in the highSP x lowSR cluster.

Linear regression did not reveal any significant age-differences between the clusters, with $F(3)=1.19$, $p>.05$. Therefore, only Gender was included as a control variable in the following analyses.

Eating Problems and Weight. A MANCOVA was performed with Cluster and Gender as independent variables and Emo, Extern, Rest, ConEat, ConBody, ConWeight and ABMI as dependent variables. Cluster was significantly associated with all dependent variables, except ABMI, with $F(3)=8.32$, $p<.001$ for Emo, $F(3)=15.75$, $p<.001$ for Extern, $F(3)=5.86$, $p=.001$ for Rest, $F(3)=15.74$, $p<.001$ for ConEat, $F(3)=8.08$, $p<.001$ for ConBody, $F(3)=8.86$, $p<.001$ for ConWeight and $F(3)=2.07$, $p>.05$ for ABMI. Although Gender was significantly associated with all dependent variables, except for Extern and ABMI, no significant Cluster x Gender interaction effects were found.

Post-hoc Tukey tests revealed that Emo was highest in the highSP x highSR and highSP x lowSR cluster, Extern was highest in the lowSP x highSR and highSP x highSR cluster, Rest was highest in the highSP x highSR and highSP x lowSR cluster, and ConEat, ConBody and ConWeight were all highest in the highSP x highSR cluster, followed by the highSP x lowSR cluster. The results of the MANCOVA and the post-hoc Tukey tests can be found in Table 4.

Cluster Analysis: Replication With the BIS/BAS Scales

The previously mentioned procedure was repeated with the BIS/BAS scales (Carver & White, 1994) as a second instrument to operationalize SP and SR. After standardization of the BIS- and BAS- scores and the removal of 14 uni- and multivariate outlier scores, first hierarchical and next k-means cluster analysis was conducted. Hierarchical cluster analyses showed again that both the four- and the five-cluster solutions met the criterion of 50% explained variance in both BIS- and BAS-scores, whereas the two- and three-cluster solutions did not. K-means cluster analysis revealed the better interpretability of the four-cluster solution compared to the five-cluster solution. The four clusters could be interpreted as a low BIS combined with (medium) high BAS cluster (lowBIS x highBAS, n=135, z=-1.04 and z=.33 respectively), a high BIS combined with (medium) low BAS cluster (highBIS x lowBAS, n=167, z=.94 and z=-.11 respectively), a (medium) low BIS combined with low BAS cluster (lowBIS x lowBAS, n=135, z=-.10 and z=-1.16 respectively), and a (medium) high BIS combined with high BAS cluster (highBIS x highBAS, n=128, z=.24 and z=1.11 respectively). Although these clusters were similar to the clusters found with the SPSRQ, the z-scores were less differentiated. This improved with the five-cluster solution, though the second and fifth cluster were rather similar and only two clusters were clearly interpretable.

When looking at the explained variance, the difference between the four and five cluster solutions was rather small, especially concerning the BIS, with the four-cluster solution explaining 63% of the variance in BIS and 67% of the variance in BAS and the five-cluster solution explaining 67% of the variance in BIS and 75% of the variance in BAS. Combined with the interpretability of both cluster solutions and the theoretical expectations, this finding seemed to suggest that the four-cluster solution was more appropriate. As such, analyses were continued with the four-cluster solution.

Binary logistic and linear regression revealed that Gender was significantly related to Cluster, with $\chi^2(3)=46.51$, $p<.001$, whereas Age was not, with $F(1)< 1$, $p>.05$. The between-cluster gender differences were similar to the previously found differences, with more boys (36.6% of the boys) than girls (15.6% of the girls) in the lowBIS x highBAS cluster and more girls (38.1% of the girls) than boys (17.0% of the boys) in the highBIS x lowBAS cluster.

A MANCOVA, with Gender and Cluster as independent variables and Emo, Extern, Rest, ConEat, ConBody, ConWeight and ABMI as dependent variables, revealed that Cluster was significantly related to Extern and marginally significantly related to ConWeight, with $F(3)=4.74$, $p<.01$ and $F(3)=1.32$, $p<.07$ respectively. Cluster was not significantly related to Emo, with $F(3)=2.31$, $p>.05$, nor to Rest, with $F(3)=1.87$, $p>.05$, nor to ConEat, with $F(3)=1.26$, $p>.05$, nor to ConBody, with $F(3)=1.32$, $p>.05$, nor to ABMI, with $F(3)=1.7$, $p>.05$. However, post hoc Tukey-tests showed several trends that were similar to the SPSRQ-based findings. More specifically, Emo was highest in the highBIS x highBAS cluster, Extern in the highBIS x highBAS cluster and the highBIS x lowBAS cluster, Rest in the highBIS x lowBAS and highBIS x highBAS clusters, ConEat in the highBIS x highBAS cluster, ConBody and ConWeight in the highBIS x lowBAS and highBIS x highBAS clusters, and ABMI in the highBIS x highBAS cluster.

Although Gender was significantly related to all dependent variables except Extern and ABMI, no significant Gender x Cluster interaction effects were found. The results of this second MANCOVA and the post-hoc Tukey tests can be found in Table 5.

Discussion

Individual differences in SP and SR, two traits originating from Gray's RST (Gray, 1970, 1982, 1987; Gray & McNaughton, 2000), may form important risk factors in the aetiology of eating problems and disorders and are, as such, receiving increasing attention within the eating disorder and obesity domain (e.g. Beck et al., 2009; Davis et al., 2004; Harrison et al., 2010; Harrison et al., 2011). This has led to the general assumption that high

SP is related to dieting and underweight whereas high SR is assumed to be related to overeating, external eating and overweight (Davis et al., 2004; Harrison et al., 2010; Harrison et al., 2011; Stice et al., 2009). Nevertheless, the exact nature of these correlations remains very ambiguous, which is in part the result of the use of inconsistent measures to operationalize SP and SR and the omission of SP in studies concerning overeating and obesity. Moreover, although adolescents form a group at risk for the development of eating problems and disorders, the role of SP and SR has rarely been examined in this age group. Therefore, it was the aim of the present study to examine the different combinations of high and low SP and SR that are naturally occurring in adolescents and whether these combinations are related to eating problems and weight.

As expected, four SPSRQ-based clusters could be retained: a lowSP x lowSR, a lowSP x highSR, a highSP x highSR and a highSP x lowSR cluster. Moreover, this result was replicated when using the BIS/BAS scales, revealing four similar clusters. Nevertheless, it should be noted that the differences between these clusters on standardized SP/BIS- and SR/BAS-scores were rather small. This could be partly explained by the fact that a non-clinical population was used, leading to mostly moderate scores. Moreover, these clusters were based on the individual scores relative to the scores of the other participants. During adolescence, it is assumed that SR-scores are heightened in most individuals (Matton et al., submitted; Romer & Hennessy, 2007), probably leading to less interindividual variety in them. As such, the combination of the relative nature of the clusters and the finding that SR is heightened during adolescence might additionally explain the rather small differences between the clusters in terms of z-scores on SP/BIS and SR/BAS.

It was found that the SPSRQ-based clusters were related to all eating problems included in the study. This was not the case for the clusters based on the BIS/BAS scales, which were only significantly related to external eating and marginally significantly related to concerns about weight. This lower number of significant effects based on the BIS/BAS scales might be explained by the fact that this instrument has been shown to be less valid in Dutch adolescents (Yu et al., 2011) compared to adults (Franken et al., 2005), as well as by the somewhat lower internal consistency of this instrument in the present sample compared to the SPSRQ. Moreover, since the clusters based on the BIS/BAS scales were less differentiated compared to the SPSRQ-based clusters, the power to detect associations with eating problems was probably lower, leading to the expected trends but few significant effects. However, the finding of great similarity between the trends based on the BIS/BAS scales en the results with the SPSRQ seem to confirm that there is indeed an association between SP, SR and eating behaviour.

More specifically, regarding emotional eating, between-cluster differences were conform with the expectations, with emotional eating being the highest in the highSP x highSR cluster, although this cluster did not significantly differ from the highSP x lowSR cluster. Also when considering the BIS/BAS scales, emotional eating was highest in the highBIS x highBAS cluster, although this trend was not significant. This finding of emotional eating occurring mostly in the highSP x highSR and highSP x lowSR clusters is in fact not surprising, since emotional eating is expected to occur mostly in response to negative emotionality (Van Strien et al., 1986), which is related to SP (Gray, 1970, 1982, 1987; Matton et al., submitted; Tellegen, 1985).

The hypotheses concerning external eating were confirmed as well, with external eating being the highest in both the lowSP x highSR and the highSP x highSR cluster, conform with the hyper-responsive hypothesis (Davis et al., 2004; Dawe & Loxton, 2004; Franken & Muris, 2005). Moreover, when using the BIS/BAS scales, again a significant effect was found with external eating occurring mostly in the highBIS x highBAS cluster, conform with the SPSRQ-based findings. However, contrary to the expectations, when using the BIS/BAS scales this cluster was followed by the highBIS x lowBAS cluster, although the difference with the lowBIS x highBAS cluster was very small.

Taken together, these findings may implicate that especially high SR or high BAS is related to external eating, in line with the hyper-responsive hypothesis, although the results based on the BIS/BAS scales do not completely support this. However, regarding this inconsistency it should be noted that, in the obesity domain, not only the hyper-responsive hypothesis receives support, but also the opposite hypothesis of a reward deficiency syndrome (Bowirrat & Oscar-Berman, 2005; Wang et al., 2001). According to this perspective, overweight results from low SR leading to overeating as a form of self-medication (Bowirrat & Oscar-Berman, 2005; Wang et al., 2001). In an attempt to reconcile both hypotheses, Davis and Fox (2008) proposed a non-linear relationship between SR and BMI, according to which the relationship between SR and BMI is best to be described as a inverted U-function, with both ends of the BMI continuum characterized by low SR (Davis & Fox, 2008). Evidence for this non-linear relation was found in adults (Davis & Fox, 2008) as well as in primary school children (Verbeken, Braet, Lammertyn, Goossens & Moens, 2011), though not yet in adolescents. This illustrates not only the complexity of the relation between SR and eating behaviours such as external eating, which might explain the partial inconsistency in results when comparing the SPSRQ with the BIS/BAS scales, but also highlights the importance of conducting more research in this area with adolescents.

Regarding restraint and concerns about eating, body shape and weight, it was expected that especially the highSP x lowSR cluster would score high, whereas the present results showed that the highSP x highSR cluster scored highest on these specific problems. Nevertheless, the difference with the highSP x lowSR cluster was only significant for concerns about eating, indicating that the highSP x lowSR and the highSP x highSR clusters were comparable in terms of restraint and the cognitive aspects of eating problems. Moreover, although only marginally significant for concerns about weight, similar trends were observed based on the BIS/BAS scales, with restraint and concerns about eating, body shape and weight highest in the highBIS x highBAS and/or highBIS x lowBAS clusters.

These findings may have several implications. First, it is possible that adolescents scoring high on both SP and SR experience more emotional internal conflict, leading to eating problems. Moreover, whereas the highSP x lowSR cluster might correspond to an AN-R profile (Harrison et al., 2010), the highSP x highSR cluster might correspond to an AN-B/P or a BN profile (Harrison et al., 2010; Fairburn et al., 2003). This is also conform with the present result that not only restraint and concerns about eating, body shape and weight are associated with high SP and SR, but also external eating. Namely, the finding that both restraint and external eating are most prominent in the same cluster is in line with the conflicting AN-B/P and BN profiles, characterized by both restraint and binge eating (APA, 2000; Harrison et al., 2010).

Finally, it is important to note that the SPSRQ-based lowSP x highSR cluster seemed to function as a protective cluster for restraint and concerns about eating, body shape and weight. Scores on these eating problems were lowest in this cluster, although the difference with the lowSP x lowSR cluster was not significant for restraint. Moreover, a similar trend was reported when using the BIS/BAS scales, although this was only marginally significant for concerns about weight.

Regarding ABMI, no significant between-cluster differences were found based on the SPSRQ, nor on the BIS/BAS scales. This could be explained by several possibilities. Firstly, the predictions regarding ABMI were related to the predictions regarding eating behaviour, with the hypothesized ‘restraint’ cluster, namely the highSP x lowSR cluster, expected to contain the lowest ABMIs. Since the expected between-cluster differences in eating problems were not fully met it is not surprising that an association between cluster and ABMI could not be found. Moreover, results showed a positive correlation between ABMI and restraint, whereas the correlation between ABMI and external eating was negative. This might indicate that adolescents with higher ABMIs may try more often to lose weight, which may cause weight loss over time due to dieting, but also weight gain if the restraint cannot be continued and causes binge eating (Fairburn et al., 2003). As such, at one point in time different associations between eating behaviour and weight may be possible.

Secondly, body mass is influenced by factors other than eating behaviour as well, such as genetics or physical activity (e.g. Silventoinen, Rokholm, Kaprio & Sorensen, 2010; Skelton, Irby, Grzywacz & Millter, 2011), which might have made it more difficult to find significant effects. Moreover, it might be easier to find a relation between behaviour and temperament than to find a relation between physical factors and temperament, since the relation between temperament and weight is probably mediated through eating behaviour. Nevertheless, previous studies did find relations between temperament and weight (e.g. Davis et al., 2004), and as such, the lack of a significant association in the present study might also be partially due to the relatively low proportion of overweight participants, which reduces the range and as such the power to find an effect. This possible lack of power is further supported by the finding that, although not significant, the observed trends were similar for the SPSRQ and the BIS/BAS scales. Moreover, these trends were in line with the expectations, with ABMI lowest in the highSP x lowSR or highBIS x lowBAS cluster and ABMI highest in the highSP x highSR or highBIS x highBAS cluster.

It is important to note that the established relations between clusters and eating problems were similar for boys and girls. However, girls appeared to be more likely than boys to belong to the highSP x lowSR or highBIS x lowBAS cluster, which seemed to form a risk cluster for restraint and concerns about eating, body shape and weight, whereas boys were more likely to belong to the lowSP x highSR or lowBIS x highBAS cluster, which appeared to form a protective factor for the same eating problems. These findings are in line with previously found gender differences in both SP and SR (Carver & White, 1994; Matton et al., submitted) and eating behaviour (e.g. Goossens, Soenens & Braet, 2009) and might provide insights into possible factors underlying gender differences in the prevalence of eating problems.

This study has several strengths. Firstly, a large sample of non-clinical adolescent boys and girls was included. This might have contributed to the representativeness of the sample as well as to the existing literature, given the lack of research in this group at risk. Also, the inclusion of both boys and girls raised the opportunity to look for gender differences in the association between temperament and eating problems, which has seldom been done due to the prominently female clinical populations (e.g. Claes et al., 2010; Dawe & Loxton, 2004; Loxton & Dawe, 2001; Loxton & Dawe, 2006). Thirdly, a wide area of eating problems was assessed, objective measurements were used to calculate the ABMI and two instruments directly based on the RST were used instead of instruments based on related theories of personality, which might have increased the interpretability of the data (Matton et al., submitted). Moreover, both SP and SR were included and their joint relation with eating problems and weight was examined, which is important given their possible interdependence. This point has especially been highlighted by Corr (2001), positing the joint subsystems hypothesis according to which the behavioural outcome of the BIS and the BAS will, in most situations, depend on both systems.

Nevertheless, some shortcomings have to be noted as well. Firstly, our data seem to suggest that there are certain combinations of SP and SR that put adolescents at risk to develop specific eating problems, whereas other combinations seem to lower that risk. However, a cross-sectional design was used, which makes it impossible to draw causal conclusions. Indeed, it is not clear yet whether high or low scores on SP and SR are a cause or a consequence of disordered eating (Harrison et al., 2010). Nevertheless, in general, nor the eating problems nor the ABMIs were extreme in the non-clinical population used in the present study, which seems to lower the probability that high or low scores on SP or SR were the result of nutritional deficits or chronic under-or overweight (Harrison et al., 2010). Moreover, genetic studies suggest that SP and SR are dispositional traits and not transient states or symptoms (Wilksch & Wade, 2009), which further seems to imply that temperament might influence eating behaviour. Nevertheless, it remains possible that especially SP increases during an eating disorder due to nutritional deficits (Harrison et al., 2010). Therefore, prospective studies should be designed to examine the evolution of SP and SR during adolescence and its causal nature in eating disorders. Moreover, since temperament is a more distal factor, it will be equally important to examine possible mediators in this relation, as mentioned by Bijttebier et al. (2009). No proximal, potentially mediating factors were included in this study, though, for example, coping strategies may form such a factor, as reported by Hasking (2006) in adolescents.

Secondly, only eating problems and ABMI were included in the study, whereas previous research shows that SR and SP may be linked to various forms of psychopathology or problem behaviour, such as, for example, hazardous drinking (e.g. Bijttebier et al., 2009; Hamilton, Sinha & Potenza, 2012). Further research should be conducted to clarify whether the potential risk clusters found in the present study are specifically associated with eating problems or with other forms of psychopathology as well.

Thirdly, the differences in the z-scores of SP and SR between the clusters were relatively small. This means that the labelling of the clusters reflects more a tendency to score higher or lower compared to other participants, but not necessarily extremely high or low scores. Future research is needed to clarify these results and might choose to include a more differentiated sample concerning age and clinical status to increase the variability of the SP/BIS- and SR/BAS-scores or might choose to include only participants with extreme high or low scores on these scales.

A fourth limitation concerns the fact that only self-report measures were used in the current study, except for weight and height, and that the questionnaires were completed in class, meaning that social desirable answers and possible lack of concentration might have biased the results. As such, it might be useful to include more behavioural measures in future research (Harrison et al., 2010).

Moreover, the validity of the SPSRQ (Torrubia et al., 2001) and the BIS/BAS scales (Carver & White, 1994) has rarely been examined in adolescents. As such, more research on the use of the SPSRQ and the BIS/BAS scales in the adolescent population is needed to further clarify the present results, especially since these instruments were originally developed for young adults (Carver & White, 1994; Torrubia et al., 2001).

Finally, the lack of an association between the clusters and ABMI might have been caused by the relatively low number of participants with extreme weights. Studies with equal groups of overweight and obese adolescents, normal weight adolescents and underweight adolescents should be conducted in the future to clarify the role of SP and SR in weight, accounting for possible mediators, such as external or emotional eating (Davis et al., 2004; van den Berg et al., 2011).

Summarized, the present findings seem to indicate that different combinations or clusters of SP and SR are occurring in the general adolescent population, with girls being more likely to be classified as highSP x lowSR and boys as lowSP x highSR. These clusters seem to differ in severity of eating problems, possibly indicating the existence of risk- and protective clusters. Especially the highSP x highSR cluster might form the most vulnerable cluster for all sorts of eating problems in adolescents, followed by the highSP x lowSR (except for external eating). The lowSP x highSR on the other hand might form the most protective cluster (except for external eating). Moreover, these findings appear to be equal among boys and girls and may provide insights into the detection of groups at risk for the development of an eating disorder. However, the results are especially pronounced when using the SPSRQ, and are supported to a far lesser extent by the BIS/BAS scales, highlighting that more research in adolescents is needed to support the use of these instruments and to clarify the possible causal role of SP and SR in eating problems and disorders.

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Tables

Table 1. Prevalence of different weight categories and of scores above the clinical cut-off for Rest, ConEat, ConBody, and ConWeight for boys and girls.

	Boys n (%)	Girls n (%)
Underweight	4 (2.6%)	7 (2.8%)
Normal Weight	129 (84.9%)	202 (81.8%)
Overweight	12 (7.9%)	27 (10.9%)
Obesity	7 (4.6%)	11 (4.5%)
Rest	1 (0.5%)	10 (3.0%)
ConEat	1 (0.5%)	7 (2.1%)
ConBody	3 (1.4%)	38 (11.6%)
ConWeight	3 (1.4%)	32 (9.8%)

Note. Rest = Restraint, ConEat = Concerns about Eating, ConBody = Concerns about Body Shape, ConWeight = Concerns about Weight.

Table 2. Mean total scores on independent and dependent variables for boys and girls and significant gender differences.

	Boys M (SD)	Girls M (SD)	t(df)
SP	57.84 (12.84)	62.97 (12.41)	-4.57(521)***
SR	70.01 (9.54)	64.54 (10.27)	6.13(522)***
BIS	18.80 (3.38)	21.41 (3.46)	-8.84 (561)***
BAS	40.90 (4.40)	40.80 (4.35)	.26 (561)
Emo	27.95 (11.05)	32.69 (10.16)	-5.21(558)***
Extern	31.03 (5.69)	30.81 (5.49)	.45(558)
Rest	1.80 (3.99)	4.60 (5.93)	-6.61(542.432)***
ConEat	2.12 (3.94)	4.28 (5.21)	-5.46(523.406)***
ConBody	5.62 (8.46)	14.46 (12.62)	-9.72(534.041)***
ConWeight	3.19 (5.08)	8.55 (7.62)	-9.76(533.356)***
ABMI	105.50 (15.56)	106.54 (16.88)	-.63(404)

*Note. M = Mean, SD = Standard Deviation, SP = Sensitivity to Punishment, SR = Sensitivity to Reward, BIS = Behavioural Inhibition System, BAS =Behavioral Activation System, Emo = Emotional Eating, Extern = External Eating, Rest = Restraint, ConEat = Concerns about Eating, ConBody = Concerns about Body Shape, ConWeight = Concerns about Weight, ABMI = Adjusted Body Mass Index; *p<.05, **p<.01, ***p<.001*

Table 3. Pearson correlations between the study variables.

	SP	SR	BIS	BAS	Emo	Extem	Rest	ConEat	ConBody	ConWeight	ABMI
SP	1										
SR	.13**	1									
BIS	.58**	-.026	1								
BAS	-.13**	.47**	-.06	1							
Emo	.31*	.16**	.23**	.06	1						
Extem	.02	.36**	.02	.28**	.48**	1					
Rest	.21**	.03	.17**	-.01	.22**	-.03	1				
ConEat	.32**	.10*	.22**	-.01	.34**	.06	.73**	1			
ConBody	.33**	.00	.28**	-.03	.26**	-.03	.75**	.79**	1		
ConWeight	.31**	.01	.27**	-.04	.24**	-.05	.74**	.78**	.94**	1	
ABMI	.00	.02	-.06	.01	-.05	-.16**	.32**	.34**	.35**	.40**	1

Note. *SP = Sensitivity to Punishment, SR = Sensitivity to Reward, BIS = Behavioural Inhibition System, BAS = Behavioral Activation System, Emo = Emotional Eating, Extern = External Eating, Rest = Restraint, ConEat = Concerns about Eating, ConBody = Concerns about Body Shape, ConWeight = Concerns about Weight, ABMI = Adjusted Body Mass Index; *p<.05, **p<.01, ***p<.001*

Table 4. MANCOVA and post-hoc Tukey tests regarding between-cluster differences in eating problems and weigh based on the SPSRQ.

	Cluster 1 (n=131, 26.3%) lowSP x lowSR	Cluster 2 (n=109, 21.8%) lowSP x highSR	Cluster 3 (n=105, 21.0%) highSP x highSR	Cluster 4 (n=154, 30.9%) highSP x lowSR	F-value
	M (SD)	M (SD)	M (SD)	M (SD)	F(3)
Emo	28.47 (9.25)$_a$	29.14 (11.90)$_a$	35.08 (9.93)$_b$	31.69 (10.02)$_{ab}$	8.32***
Extern	29.30 (4.54)$_a$	33.01 (5.38)$_b$	33.59 (5.12)$_b$	29.58 (5.06)$_a$	15.75***
Rest	22.27 (9.42)$_{ac}$	18.89 (8.43)$_c$	26.84 (9.65)$_b$	23.72 (8.74)$_{ab}$	5.86**
ConEat	2.13 (2.78)$_{ab}$	1.84 (3.00)$_b$	6.36 (6.90)$_c$	3.8 (4.66)$_a$	15.74***
ConBody	8.97 (9.90)$_{ab}$	7.26 (10.03)$_b$	15.71 (13.90)$_c$	13.26 (12.13)$_{ac}$	8.08***
ConWeight	5.42 (5.91)$_{ab}$	4.15 (5.73)$_b$	9.59 (8.51)$_c$	7.27 (7.34)$_{ac}$	8.86***
ABMI	105.88 (15.30)$_a$	105.27 (16.60)$_a$	109.64 (16.70)$_a$	103.58 (15.90)$_a$	2.07

*Note. M = Mean, SD = Standard Deviation, SP = Sensitivity to Punishment, SR = Sensitivity to Reward, Emo = Emotional Eating, Extern = External Eating, Rest = Restraint, ConEat = Concerns about Eating, ConBody = Concerns about Body Shape, ConWeight = Concerns about Weight, ABMI = Adjusted Body Mass Index; Means not sharing subscripts differ significantly, as indicated by post-hoc contrasts (Tukey, p<.05); *p<.05, **p<.01, ***p<.001*

Table 5. Replication of the MANCOVA and post-hoc Tukey tests regarding between-cluster differences in eating problems and weight based on the BIS/BAS scales

	Cluster 1 (n=135, 23.9%) lowBIS x highBAS	Cluster 2 (n=167, 29.6%) highBIS x lowBAS	Cluster 3 (n=135, 23.9%) lowBIS x lowBAS	Cluster 4 (n=128, 22.7%) highBIS x highBAS	F-value
	M (SD)	M (SD)	M (SD)	M (SD)	F(3)
Emo	27.93 (11.19)$_a$	31.26 (10.26)$_{ab}$	31.09 (9.95)$_{ab}$	33.79 (10.93)$_b$	2.31
Extern	31.43 (5.10)$_{ab}$	31.45 (5.10)$_b$	29.49 (4.97)$_a$	32.60 (5.60)$_b$	4.74**
Rest	2.08 (3.46)$_a$	4.53 (5.58)$_b$	3.87 (5.41)$_{ab}$	4.08 (6.30)$_b$	1.87
ConEat	2.43 (4.16)$_a$	3.79 (4.19)$_a$	3.62 (4.92)$_a$	4.13 (5.97)$_a$	1.26
ConBody	7.38 (8.93)$_a$	13.46 (11.66)$_b$	10.89 (12.11)$_{ab}$	12.29 (13.43)$_b$	1.32
ConWeight	3.85 (5.22)$_a$	7.71 (7.19)$_b$	6.56 (7.20)$_b$	7.49 (8.00)$_b$	2.53$^+$
ABMI	105.76 (15.63)$_a$	103.64 (14.93)$_a$	103.97 (14.21)$_a$	108.02 (17.08)$_a$	1.70

Note. M = Mean, SD = Standard Deviation, BIS = Behavioural Inhibition System, BAS = Behavioural Activation System, Emo = Emotional Eating, Extern = External Eating, Rest = Restraint, ConEat = Concerns about Eating, ConBody = Concerns about Body Shape, ConWeight = Concerns about Weight, ABMI = Adjusted Body Mass Index; Means not sharing subscripts differ significantly, as indicated by post-hoc contrasts (Tukey, $p<.05$); $^+p<.07$, $^*p<.05$, $^{**}p<.01$, $^{***}p<.001$

Chapter 5

The role of temperament in short-term symptom evolution in patients with an eating disorder [4]

Abstract

Eating Disorders (EDs) are known as persistent disorders with a relatively high diagnostic instability. An increasing amount of cross-sectional research suggests that temperament might play an important role in the onset of EDs, but few studies have examined the role of temperament in the course of EDs. Therefore, the goal of the present study was to examine the predictive value of several temperament traits and their interaction on short-term symptomatic improvement, based on the Reinforcement Sensitivity Theory and Cloninger's model of personality.

Self-report questionnaires were administered twice in a clinical sample of patients with a diagnosed ED (n=58) with a time span of six months between the first and the second measurement moment. Hierarchic linear regression analyses were performed.

A positive three-way interaction effect between the traits Harm Avoidance, Novelty Seeking and Persistence was found on body dissatisfaction in each of the ED diagnoses and on bulimic symptoms in patients with Anorexia Nervosa of the Binge/Purge type, Bulimia Nervosa and Binge Eating Disorder. A negative interaction effect between Harm Avoidance and Novelty Seeking was also found on restrained eating in each

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[4] Matton, A., Goossens, L., Vervaet, M., & Braet, C. The role of temperament in short-term symptom evolution in patients with an eating disorder. *Unpublished results*

of the ED diagnoses. Sensitivity to Punishment positively predicted body mass index increase in patients with underweight.

The present results suggest that, depending on the specific symptom under examination, the interaction between several temperament traits might be involved in short term symptomatic evolution in patients with an ED.

Introduction

Eating disorders (EDs) are known as severe and persistent psychological disorders with a relatively high mortality rate. Moreover, patients suffering from an ED show a lot of diagnostic instability, often shifting between different specific ED-types over time (Castellini, Lo Sauro, Mannucci, Ravaldi, Rotella, Faravelli, & Ricca, 2011; Harrison, O'Brien, Lopez, & Treasure, 2010; Milos, Spindler, Schnyder, & Fairburn, 2005). However, maintaining factors leading to this high persistency of the disorder are not well understood yet.

There is evidence that the different ED diagnoses of Restrictive Anorexia Nervosa (AN-R), Binge/Purge Anorexia Nervosa (AN-B/P), Bulimia Nervosa (BN) and Binge Eating Disorder (BED) may share a temperamental vulnerability (Atiye, Miettunen, & Raevuori-Helkamaa, 2015; Cassin & Von Ranson, 2005; Harrison et al., 2010; Matton, Goossens, Vervaet, & Braet, 2015), which might play a role in the onset of these EDs. In diathesis-stress models on the development of psychopathology (Hankin & Abela, 2005), these temperament factors were seen as trait-like personal characteristics that interact with environmental stressors. They can act both as a general vulnerability factor as well as a disorder-specific factor. Indeed, several studies that will be discussed below, already show that in addition to transdiagnostic similarities regarding temperament profiles, there may be temperamental differences between the different ED types as well (Cassin & Von Ranson, 2005; Harrison et al., 2010; Matton et al., 2015; Vervaet, Van Heeringen, & Audenaert, 2004), which may in turn be involved in the differential manifestation of EDs. Because trait-like characteristics are less easy to change in treatment, it is generally assumed that specific temperament profiles can also explain why some people stay vulnerable, show only slow improvement or easily indulge in transdiagnostic cross-overs or relapse. This assumption, although highly important for treatment, was only studied recently (Bloks, Hoek, Callewaert, & van Furth, 2004; Glashouwer, Bloot, Veenstra, & de Jong, 2014; Rowe, Jordan, McIntosh, Carter, Frampton, Bulik, & Joyce, 2011; Segura-Garcia, Chiodo, Sinopoli, & de Fazio, 2013; Tozzi et al., 2005) and as such, many uncertainties exist on the role of temperament in the persistence of EDs, as will be illustrated below.

The majority of the cross-sectional studies on the role of temperament in EDs are based on the Reinforcement Sensitivity Theory (Gray, 1970; 1982; 1987; Gray & McNaughton, 2000) and on the associated personality model of Cloninger (Cloninger, 1987; Cloninger, Svrakic, & Przybeck, 1993). The Reinforcement Sensitivity Theory is a psychobiological model postulating that there are three biological systems directing human motivational behaviour and emotion. These systems are the Behavioural Activation System (BAS), the Behavioural Inhibition System (BIS), and the Fight-Flight-Freeze System (FFFS). The BAS is activated in response to appealing stimuli and leads to approach behaviour, whereas the BIS is activated by goal-conflict and leads to inhibition of behaviour. The FFFS is activated by signals of punishment and leads to aggressive or escape behaviour (Gray & McNaughton, 2000). The temperament traits Sensitivity to Punishment and Sensitivity to Reward, defined as the proneness to detect signals of punishment/reward in the environment and to experience negative/positive affect in punishing situations (Davis & Fox, 2008), stem from this model. More specifically, Sensitivity to Punishment refers to interindividual differences in the sensitivity of the BIS and the FFFS and Sensitivity to Reward refers to interindividual differences in the sensitivity of the BAS (Harrison et al., 2010; Matton et al., 2015). It is hypothesized that these traits are involved in disordered eating behaviour, since eating behaviour is partly directed by human motivation and emotion (Bruce, Martin, & Savage, 2011; Shin, Zheng, & Berthoud, 2009). In line with this assumption, empirical evidence has been found for altered levels of Sensitivity to Punishment and

Reward in patients with an ED (Glashouwer et al., 2014; Harrison et al., 2010; Matton et al., 2015). More specifically, Sensitivity to Punishment seems to be increased in patients with AN-R, AN-B/P and BN whereas Sensitivity to Reward seems to be increased specifically in patients with BN. However, the results on Sensitivity to Reward are often inconsistent, with some studies reporting increased Sensitivity to Reward in BN patients, others in AN patients and others report no altered levels of Sensitivity to Reward in ED patients (Glashouwer et al., 2014; Harrison et al., 2010; Jappe et al., 2011; Matton et al., 2015).

The second model that lies at the basis of many studies on temperament in EDs is Cloninger's model of Personality (Cloninger, 1987; Cloninger et al., 1993). This model contains four innate temperament dimensions as well as three acquired character dimensions. The four temperament dimensions are Harm Avoidance, Novelty Seeking, Persistence and Reward Dependency. Harm Avoidance pertains to the tendency of inhibiting responses in the face of aversive stimuli, leading to the avoidance of punishment and non-reward. Novelty Seeking is defined as the tendency to respond actively to novel stimuli, leading to reward or escape from punishment. Persistence refers to the level of perseverance despite frustration and fatigue and Reward Dependency is defined as the positive response to conditioned signals of reward (Cloninger, 1987; Cloninger et al., 1993). The three character dimensions are Self-Directedness, Cooperation and Self-Transcendence. These are defined as the ability to identify the self as autonomous, as an integral part of society, and as part of the whole universe and in union with all things respectively (Cloninger, 1987; Cloninger et al., 1993). Since the focus of the present study is on innate temperament traits, these character traits will not be further discussed.

Cloninger's model of personality is associated with the Reinforcement Sensitivity Theory in the sense that it proposes two major temperament dimensions that are responsible for inhibition and activation of behaviour respectively, namely Harm Avoidance and Novelty Seeking (Cloninger, 1987). These traits are therefore theoretically related to the sensitivity of the BIS in the case of Harm Avoidance and to the sensitivity of the BAS in the case of Novelty Seeking (Mardaga & Hansenne, 2007). As such, associations are expected between Sensitivity to Punishment and Harm Avoidance as well as between Sensitivity to Reward and Novelty Seeking. Previous research in healthy subjects indeed found evidence for the association between Harm Avoidance and BIS sensitivity/Sensitivity to Punishment and between Novelty Seeking and BAS sensitivity/Sensitivity to Reward (Hansenne & Ansseau, 1999; Hansenne, Pinto, Pitchot, Reggers, Scantamburlo, Moor, & Ansseau, 2002; Mardaga & Hansenne). As such, it is no surprise that findings regarding the role of Harm Avoidance and Novelty Seeking in patients with an ED are similar to the findings regarding the role of Sensitivity to Punishment and Reward. Indeed, increased levels of Harm Avoidance have been reported in patients with AN-R, AN-B/P and BN (Atiye, et al., 2015; Cassin & Von Ranson, 2005; Harisson et al., 2010). Moreover, decreased levels of Novelty Seeking have been found in AN patients, especially in the case of AN-R, and increased levels of this trait have been found in ED patients with bulimic symptoms (Atiye et al., 2015; Cassin & Von Ranson, 2005; Harisson et al., 2010; Matton et al., 2015).

On top of the traits Harm Avoidance and Novelty Seeking, that are related to the Reinforcement Sensitivity Theory, Cloninger’s model of personality proposes two additional temperament traits, as previously mentioned. Concerning these additional temperament dimensions, cross-sectional research has revealed altered levels of the trait Persistence in ED patients (Atiye et al., 2015; Cassin & Von Ranson, 2005). More specifically, patients with an ED, except for patients with BED, score significantly higher on this trait compared to healthy controls, with AN patients having the highest scores on this trait. On the other hand, the trait Reward Dependency has not been found to be clearly altered in specific ED types (Atiye et al., 2015; Cassin & Von Ranson, 2005). Although this trait seems to increase after recovery from AN (Atiye et al., 2015), no cross-sectional differences are found between ED patients and healthy controls on this trait (Atiye et al., 2015; Cassin & Von Ranson, 2005). As such, the focus of the present study was on Harm Avoidance, Novelty Seeking and Persistence, but not on Reward Dependency.

Based on these cross-sectional findings of altered levels of Sensitivity to Punishment and Reward, Harm Avoidance, Novelty Seeking and Persistence in patients with an ED, it is assumed that these traits are also involved in the course of EDs. However, much less research has been done on the predictive value of temperament for the course of EDs. So far, a handful of studies on the role of temperament in the course of EDs are available. One study examined the predictive role of Sensitivity to Punishment and Sensitivity to Reward and their interaction for symptom improvement in AN-R and AN-B/P patients over one year, but found no significant results (Glashouwer et al., 2014). Three other studies based on Cloninger’s model of personality reported mixed evidence: two studies found no evidence that temperament might predict symptom improvement (Bloks et al., 2004; Rowe et al., 2011) whereas, according to a third study, the traits Novelty Seeking and Harm Avoidance are positively associated with symptom improvement in AN and BN, with low Novelty Seeking being the strongest predictor of pour outcome (Segura-Garcia et al., 2013).

Thus it remains unclear whether temperament is especially a predispositional factor (Bloks et al., 2004) or whether temperament might also influence the evolution of EDs and functions as a maintaining factor (Segura-Garcia et al., 2013). An important limitation in the few studies that have been conducted so far is that most of them focus on the main effects of single traits, whereas it seems plausible that there is an interaction between several traits influencing symptomatic evolution (Corr, 2002; Glashouwer et al., 2014). More specifically, according to the joint subsystems hypothesis, the BIS and the BAS are only activated independently from each other when only appetitive or aversive stimuli are present (Corr, 2002). However, many situations contain mixed signals of punishment and reward. It is assumed that this leads to the simultaneous activation of both the BIS and the BAS. The behavioural outcome depends then on the relative strength of one system compared to the other (Corr, 2002). As such, it seems important to investigate the interaction of SP and SR in influencing eating behaviour and to focus more on temperamental profiles instead of separate traits. To our best knowledge, the study of Glashouwer et al. (2014) is the only study so far including an interaction term. In this study, no significant main or interaction effects of SP and SR were found on evolution in ED symptoms. However, only AN patients were included in the study. Another limitation in the current literature on this topic is that the outcome variables are mostly limited to whether or not participants still meet the diagnostic criteria for an ED on the long term or have gained weight. Short term symptomatic changes are far less studied, although they can be detected earlier in clinical practice on dimensional measures compared to diagnostic and weight changes. Moreover, it has been shown that early symptomatic improvement predicts a better outcome compared to later improvement (Accurso, Ciao, Fitzsimmons-Craft, Lock, & Le Grange, 2014; Begin, Cagnon-Girouard, Aime, & Ratte, 2013; le Grange, Doyle, Crosby, & Chen, 2008; Lock, Couturier, Bryson, & Agras, 2006). This implies that gaining insight into predictors of early symptomatic improvement might be clinically relevant.

Based on these considerations, the present research goal was to examine whether temperament traits as well as their interaction are predictive for symptom improvement in a heterogeneous sample of treatment seeking patients with different ED diagnoses. Both the core cognitive symptoms of EDs (e.g. body dissatisfaction and drive for thinness) were included as dependent variables as well as the behavioural symptoms of restrained eating and bulimic symptoms (Fairburn, Cooper, & Shafran, 2003). Reduction in the level of body dissatisfaction and drive for thinness was examined in all ED types since these are transdiagnostic characteristics of EDs (Fairburn et al., 2003) and can be seen in general as a marker of improvement. Reduction in restrained eating and bulimic symptoms was examined in all ED types as well. Although patients with BED often report a less restrictive eating pattern and patients with AN-R do not meet the criteria of binge/purge symptoms, an increase in these behaviours is considered harmful for these patients as well. In addition, increase in Body Mass Index (BMI) was examined in AN-R and AN-B/P patients, since these diagnostic categories are characterized by underweight and weight gain is a target specific for this subsample.

Regarding the role of temperament, the focus was on those traits that have been found to be altered in ED patients on a cross-sectional basis, both based on the Reinforcement Sensitivity Theory (e.g. Sensitivity to Punishment and Sensitivity to Reward), as well as on Cloninger’s model of personality (e.g. Harm Avoidance, Novelty Seeking and Persistence) (Cassin & Von Ranson, 2005; Harrison et al., 2010; Matton et al., 2015). Although the models share commonalities, measures of both were used in the present study. This was done because this allowed to replicate the findings based on one model/instrument and because Cloninger’s model of personality allows examining the interaction with a third trait, Persistence, on top of the interaction between the two traits responsible for inhibition and activation of behaviour.

Regarding Sensitivity to Punishment and Reward, there seem to be two different possibilities regarding the nature of these trait-interactions, bearing in mind the inconsistent findings in the literature to date. First, it is possible that the combination of low Sensitivity to Punishment with low Sensitivity to Reward is associated with decreases in both cognitive and behavioural ED-symptoms, since several studies suggest that especially higher scores on both traits are associated with ED symptoms generally (Glashouwer et al., 2014; Jappe et al., 2011; Loxton & Dawe, 2001; Loxton & Dawe, 2006). Secondly, based on cross-sectional studies concerning Sensitivity to Punishment and Sensitivity to Reward (Harrison et al., 2010; Matton et al., 2015), it also seems possible that in the specific case of restrained eating, especially low Sensitivity to Punishment combined with high Sensitivity to Reward predicts decreases in this symptom. Regarding BMI increase, results were expected to be similar to the results for restrained eating. In other words: a temperament profile that predicts decreased restrained eating, is expected to predict increased BMI as well.

Based on Cloninger's model of personality, this study was taken one step further by examining the three-way interaction between Harm Avoidance (as a proxy measure of Sensitivity to Punishment), Novelty Seeking (as a proxy measure of Sensitivity to Reward) (Mardaga & Hansenne, 2007) and Persistence. Consistent with the previously discussed hypotheses regarding Sensitivity to Punishment and Sensitivity to Reward, there are two possibilities. First, it is possible that the combination of low Harm Avoidance, low Novelty Seeking and low Persistence predicts decreases in ED symptoms generally (Atiye et al., 2015; Cassin & Von Ranson, 2005). However, a second possibility is that low Harm Avoidance, combined with high Novelty Seeking and low Persistence is associated with decreases in restrained eating, whereas low Harm Avoidance, combined with low Novelty Seeking and high Persistence might be associated with decreases in bulimic symptoms (Atiye et al., 2015; Cassin & Von Ranson, 2005). Again, concerning BMI, results were expected to be similar to the results for restrained eating.

To test these hypotheses, self-report data was gathered from patients with a diagnosed ED at two different time points, with a period of six months in between. This time frame was chosen because of the importance of early symptom improvement (Accurso et al., 2014; Begin et al., 2013; Le Grange et al., 2008; Lock et al., 2006) and the clinical relevance of gaining insight into predictors of early improvement.

Material and Methods

Participants and Procedure

108 female participants aged 14 till 54 years (M=22.90, SD=7.67) were recruited at a University Hospital's Centre for EDs between September 2012 and September 2013 (T1). Participants diagnosed with AN-R (n=42), AN-B/P (n=14), BN (n=39) and BED (n=13) were included in the study. Diagnoses were assigned by a trained psychologist after a clinical interview and were based on the DSM-IV-TR criteria (American Psychiatric Association (APA), 2000). Average self-reported duration of the ED at T1 was 5.99 years (SD=6.53, range <1-40 years). Average BMI at T1 was 19.84 (SD=5.96, range 11.40-43.80). The study questionnaires were administered after the completion of active informed consents by the participants. The parents of participants under the age of 18 were informed about the study as well.

T2 took place six months after the completion of the questionnaires at T1. At T2, participants who were still in treatment were contacted by their therapist. Those who were no longer in treatment were contacted by telephone or by e-mail by the researcher and were requested to complete several questionnaires at home. All participants received the active informed consents and the study questionnaires by mail or by their therapist and completed them at home. Data at T2 were available for 58 participants or 53.7% of the sample at T1. Of these participants 49 (84.5%) still followed treatment at T2. More specifically, 40 participants (69%) still followed CBT at the Centre for EDs and nine participants (15.5%) followed treatment outside the Centre for EDs. Average BMI at T2 was 20.63 (SD=6.26, range 13.10-39.60).

Independent samples t-tests were performed to compare the participants who completed both measurement moments with those who dropped out on age, self-reported ED duration, personality variables and ED symptoms. Participants who completed both measurement moments versus participants who dropped out did not differ in age, or in the personality variables or the severity of ED-symptoms at T1. However, a significant difference in self-reported ED duration was found ($t(68.55)=-2.30$, $p<.05$), with participants who completed both measurement moments reporting a shorter ED duration (M=4.54 years, SD=4.44) compared to the participants who dropped out (M=7.59 years, SD=7.97).

A logistic regression was also performed, to test whether ED diagnosis was associated with drop-out, but no significant association was found ($\chi^2(3)=1.33$, $p>.05$, Nagelkerke $R^2=.02$). More specifically, 25 (59.5%) of the original 42 AN-R patients, 8 (57.1%) of the original 14 AN-B/P patients, 19 (48.7%) of the original 39 BN patients and 6 (46.2%) of the original 13 BED patients participated at T2.

Secondly, participants who were still in treatment at T2 were compared with participants who did not follow treatment at T2 on the personality variables and ED symptoms. No differences were found in the personality variables or ED symptoms at T1. However, at T2 a significant higher level of the ED symptoms body dissatisfaction ($t(21.59)=3.92$, $p<.01$), drive for thinness ($t(54)=2.67$, $p<.05$) and bulimic symptoms ($t(54)=2.04$, $p<.05$) was found in patients who were no longer in treatment compared to patients who were still in treatment. More specifically, participants who were not in treatment at T2 had a mean score of 48.67 (SD=4.74) on body dissatisfaction, 37.44 (SD=5.50) on drive for thinness and 24.11 (SD=8.05) on bulimic symptoms at T2 whereas the mean scores in participants still following treatment at T2 were 40.46 (SD=9.16), 29.30 (SD=8.79), and 17.79 (SD=8.60) respectively.

Materials

Sensitivity to Punishment and Sensitivity to Reward Questionnaire. The Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ) (Torrubia, Avila, Molto & Caseras, 2001) was based on the Reinforcement Sensitivity Theory and consists of a Sensitivity to Punishment subscale and a Sensitivity to Reward subscale. The adapted version for adolescents was used because participants were included from the age of 14 years. This questionnaire contains 22 items for each subscale, answered on a five point scale ranging from ‘never’ to ‘always’. Higher scores indicate higher levels of the trait being measured. Both the original and the adapted scales present satisfactory internal consistency as well as convergent and discriminant validity (Torrubia et al., 2011; Vandeweghe, Matton, Beyers, Vervaet, Braet, & Goossens, 2016). The validity of the Dutch SPSRQ has been shown to be similar to the validity of the original version in ED patients (Beck, Smits, Claes, Vandereycken, & Bijttebier, 2009). Cronbach’s alpha in the present study was .91 for Sensitivity to Punishment and .85 for Sensitivity to Reward.

Temperament and Character Inventory. The Temperament and Character Inventory (TCI) (Cloninger et al., 1993) was developed to measure the different personality dimensions proposed by Cloninger’s model of personality (Cloninger, 1978; Cloninger et al., 1993). For the present study, only the subscales Harm Avoidance (35 items), Novelty Seeking (40 items), and Persistence (eight items) were included. The items are formulated as statements and have to be answered by marking the answer ‘correct’ or ‘incorrect’. Higher scores indicate higher levels of the trait being measured. The internal consistency of the TCI in the present sample could not be calculated, since only the total scores were available for the study due to the standard scoring procedure at the ED-centre. Nevertheless, previous research has demonstrated sufficient internal consistency of the TCI in clinical populations, with Cronbach’s alpha between .62 and .90 for the temperament subscales (Duijsens, Spinhoven, Goedkoop, Spermon, & Eurelings-Bontekoe, 2000). Moreover, the TCI has been widely used to study personality in clinical ED populations (Atiye et al., 2015; Cassin & Von Ranson, 2005; Harrison et al., 2010).

Eating Disorder Inventory. To measure the intensity of body dissatisfaction, drive for thinness and bulimic symptoms (binge eating, binge craving, purging), the Eating Disorder Inventory-2 (EDI-2) (Garner, 1991; Garner, Olmsted, & Polivy, 1983) was used, which is one of the most widely used self-report questionnaires in ED research (Rowe et al., 2011). The total EDI-2 consists of eight subscales, of which three were designed to measure ED symptoms and five to measure characteristics relevant to EDs. For the objectives of the present study, only the first three subscales, namely Body Dissatisfaction (nine items), Drive for Thinness (seven items) and Bulimic Symptoms (seven items), were included. The items are answered on a six point scale ranging from ‘never’ to ‘always’. The higher the score, the higher the intensity of the symptoms is. The internal consistency in the present study was good, with Cronbach’s alpha equal to .92 for Body Dissatisfaction, .93 for Drive for Thinness and .91 for Bulimic Symptoms at T2. Cronbach’s alpha at T1 could not be calculated because only the total scores were available due to the standard scoring procedure of the ED-centre.

Dutch Eating Behaviour Questionnaire. The Dutch Eating Behaviour Questionnaire (DEBQ) (Van Strien, Frijters, Bergers, & Defares, 1986) was developed to measure different eating styles and contains 33 items, divided into three subscales. We only included the subscale Restrained Eating (ten items). The items have to be answered on a five point scale, ranging from never to very often. The DEBQ has high internal consistency and factorial validity43. Cronbach's alpha for Restrained Eating at T2 was .95. Cronbach's alpha at T1 could not be calculated because only the average total scores were available due to the standard scoring procedure of the ED-centre. Average scores instead of the total scale score was also used at T2 for this reason.

Data Analytic Plan

First, the correlations between descriptive variables (age and self-reported ED duration) and the dependent variables (Body Dissatisfaction, Drive for Thinness, Restrained Eating, Bulimic Symptoms, BMI) were examined to determine which descriptive variables should be taken into account in the following analyses.

Secondly, it was examined whether or not there was a significant change in the ED symptoms between T1 and T2. To test this, paired sample t-tests were conducted to compare the mean scores on a specific symptom between T1 and T2 for the relevant subsample of the participants. More specifically, changes in Body Dissatisfaction, Drive for Thinness, Restrained Eating and Bulimic Symptoms were examined in the total sample and changes in BMI were examined in patients with AN-R and AN-B/P.

Next, the independent variables Sensitivity to Punishment, Sensitivity to Reward, Harm Avoidance, Novelty Seeking and Persistence were standardized and interaction terms were computed. We conducted separate linear regression analyses to test the interaction effect of Sensitivity to Punishment and Sensitivity to Reward and of Harm Avoidance, Novelty Seeking and Persistence on symptom evolution, each time within the relevant subsample of the participants. Thereby we controlled for the level of these symptoms at T1 by including the T1 measures of these symptoms in the first step of the analysis. Based on the correlation analyses, control variables were included in step one when necessary. In the second step, the standardized scores on Sensitivity to Punishment/Harm Avoidance, Sensitivity to Reward/ Novelty Seeking and Persistence were added, in the third step the two-way interaction terms between the temperament variables were included, and, in the case of analyses based on Cloninger's model of personality, in the fourth step the three-way interaction term was added.

Results

Descriptives

Age and self-reported ED duration were not significantly correlated with the dependent variables Body Dissatisfaction (r=.10, p>.05 for age, r=-.02, p>.05 for ED duration), Drive for Thinness (r=-.03, p>.05 for age, r=-.13, p>.05 for ED duration), Restrained Eating (r=-.10, p>.05 for age, r=-.21, p>.05 for ED duration) and Bulimic Symptoms (r=.11, p>.05 for age, r=.16, p>.05 for ED duration) at T2. However, both age and self-reported ED duration were significantly correlated with BMI at T2, with r=.40, p<.01 for age and r=.32, p<.05 for ED duration. As such, these variables were included as control variables in the regression analyses with BMI at T2 as dependent variable.

Regarding short term symptomatic change, a significant increase in Body Dissatisfaction was observed for the total sample, a significant decrease was observed in Bulimic Symptoms for the total sample and a significant increase in BMI was found for patients with a diagnosis of AN-R or AN-B/P at T1. No significant change was observed in Drive for Thinness and Restrained Eating (see Table 1).

Symptom Evolution

The Predictive Effect of Temperament on Body Dissatisfaction. A first hierarchic linear regression analysis was conducted to test the predictive value of Sensitivity to Punishment, Sensitivity to Reward and their interaction for change in Body Dissatisfaction in patients with AN-R, AN-B/P, BN and BED. The final model, including Body Dissatisfaction at T1, Sensitivity to Punishment, Sensitivity to Reward and the interaction term between Sensitivity to Punishment and Sensitivity to Reward as predictors, was not significant. When looking at the t-tests for the different predictors separately, only a significant positive main effect of Body Dissatisfaction at T1 for Body Dissatisfaction at T2 was found.

Secondly, a hierarchic linear regression was performed, testing the main and interaction effects of Harm Avoidance, Novelty Seeking and Persistence on Body Dissatisfaction at T2 after controlling for Body Dissatisfaction at T1. Again, this was examined in the total sample consisting of patients with AN-R, AN-B/P, BN and BED. The fourth and final model, including all predictors as well as the interactions between the different traits, was significant. When looking at the t-tests for each predictor of this model, a significant positive main effect of Body Dissatisfaction at T1, as well as a significant positive three-way interaction effect of Harm Avoidance, Novelty Seeking and Persistence on Body Dissatisfaction at T2 was found.

The results for each step of the regression analyses can be found in Table 2. For reasons of parsimony, the regression coefficients and t-tests for the separate predictors are only presented for the final models.

The Predictive Effect of Temperament on Drive for Thinness. First, the predictive effect of Sensitivity to Punishment, Sensitivity to Reward and their interaction on change in Drive for Thinness was examined in the total sample. None of the models were significant, except for the first model including Drive for Thinness at T1 as predictor. A positive effect of Drive for Thinness at T1 on Drive for Thinness at T2 was found.

Secondly, the predictive effect of Harm Avoidance, Novelty Seeking, Persistence and their interaction on Drive for Thinness at T2 after controlling for Drive for Thinness at T1 was tested. Again, none of the models was significant except for the first model including Drive for Thinness at T1 as predictor. The results for each step of the regression analyses can be found in Table 3. For reasons of parsimony, the regression coefficients and t-tests for the separate predictors are only presented for the final models.

The Predictive Effect of Temperament on Restrained Eating. The predictive effect of Sensitivity to Punishment, Sensitivity to Reward and their interaction on change in Drive for Thinness was examined in the total sample. None of the models were significant, except for the first model including Restrained Eating at T1 as predictor. A positive effect of Restrained Eating at T1 on Restrained Eating at T2 was found.

In a second hierarchic regression analyses, the main and interaction effects of Harm Avoidance, Novelty Seeking and Persistence were examined. The third model, including the two way interaction terms between the three traits, was significant. The t-tests revealed a significant negative interaction effect between Harm Avoidance and Novelty Seeking. As depicted in Figure 1, high Harm Avoidance combined with low Novelty Seeking is associated with higher levels of Restrained Eating at T2, after controlling for Restrained Eating at T1.

The results for each step of the regression analyses can be found in Table 4. For reasons of parsimony, the regression coefficients and t-tests for the separate predictors are only presented for the final models.

The Predictive Effect of Temperament on Bulimic Symptoms. In a first hierarchic linear regression analysis the predictive effect of Sensitivity to Punishment, Sensitivity to Reward and their interaction on Bulimic Symptoms at T2 after controlling for Bulimic Symptoms at T1 was examined. This was done in the total sample. The results of the third and final model, including all predictors as well as the interaction between Sensitivity to Punishment and Sensitivity to Reward, only revealed a significant positive main effect of Bulimic Symptoms at T1.

Secondly, a hierarchic linear regression analysis was conducted to test the main and interaction effects of Harm Avoidance, Novelty Seeking and Persistence on Bulimic Symptoms at T2 after controlling for Bulimic Symptoms at T1 in the total sample. The fourth model, including all predictors as well as the interaction terms between the traits, was significant. When looking at the t-tests for the different predictors separately, a significant positive interaction effect of Harm Avoidance, Novelty Seeking and Persistence on Bulimic Symptoms at T2 was found.

The results for each step of the regression analyses can be found in Table 5. For reasons of parsimony, the regression coefficients and t-tests for the separate predictors are only presented for the final models.

The Predictive Effect of Temperament on BMI. In a first hierarchic linear regression analysis it was examined whether Sensitivity to Punishment, Sensitivity to Reward or their interaction was predictive for BMI increase in patients with AN-R and AN-B/P. The third model, including all predictors as well as the interaction term between Sensitivity to Punishment and Sensitivity to Reward, was not significant. The t-tests for the different predictors separately revealed a significant positive effect of ED duration and of Sensitivity to Punishment on BMI at T2.

In the second regression analysis, the main and interaction effects of Harm Avoidance, Novelty Seeking and Persistence on BMI increase in AN-R and AN-B/P patients was tested. The fourth model, including all predictors as well as all interaction terms between the traits was not significant. Based on the results for the separate predictors of this model, a significant positive main effect of ED duration was found.

The results for each step of the regression analyses can be found in Table 6. For reasons of parsimony, the regression coefficients and t-tests for the separate predictors are only presented for the final models.

Discussion

The goal of the present study was to examine the predictive value of temperament for short-term evolution of ED symptoms based on two different models. First, based on the Reinforcement Sensitivity Theory, the interaction of Sensitivity to Punishment and Sensitivity to Reward in predicting the evolution in body dissatisfaction, drive for thinness, restrained eating, bulimic symptoms and BMI was tested for specific ED diagnoses. Secondly, based on Cloninger's model of Personality, it was examined whether the interaction between the traits Harm Avoidance (related to Sensitivity to Punishment), Novelty Seeking (related to Sensitivity to Reward), and the additional trait Persistence was predictive for evolution in the same ED symptoms for the same specific ED diagnoses.

First, it can be noted that the results based on the SPSRQ (Torrubia et al., 2014) and the results based on the TCI (Cloninger et al., 1993) were not consistent. This might be partly explained by the fact that both questionnaires measure slightly different concepts. An additional reason for the inconsistency is that results based on the TCI show evidence for a three-way interaction effect in the case of body dissatisfaction and bulimic symptoms, whereas the SPSRQ takes only two temperament dimensions into account and cannot detect these interactions.

The hypotheses were not confirmed based on the SPSRQ-results and were partly confirmed based on the TCI-results. More specifically, when looking at the SPSRQ-results, no predictive effect of Sensitivity to Punishment and Sensitivity to Reward or their interaction was found for the evolution in body dissatisfaction, drive for thinness, restrained eating or bulimic symptoms. This in line with the findings of Glashouwer et al. (2014), indicating that Sensitivity to Punishment and Reward are independently associated with ED symptoms in patients with AN on a cross-sectional basis, but not on a longitudinal basis. However, the significant positive main effect of Sensitivity to Punishment on BMI at T2 contradicts the findings of Glashouwer et al. (2014). More specifically, previous findings indicated that high Sensitivity to Punishment was associated with a higher percentage of underweight on a cross-sectional basis and no association was found between Sensitivity to Punishment and BMI one year later (Glashouwer et al., 2014), whereas in the present study, high Sensitivity to Punishment seems to be associated with BMI increase in patients with AN. Moreover, in addition, a significant positive effect of ED duration was found on BMI increase. As the level of Sensitivity to Punishment has previously been associated with the severity of the illness (Glashouwer et al., 2014) it seems that in the present sample, the most severe cases (in terms of high SP and longest ED duration) improved the most in terms of BMI. In interpreting these results, it should be kept in mind that those patients with the longest ED duration at T1 were more likely to drop-out and were not included in these analyses. As previously described, the mean ED duration in participants who dropped out was almost double the mean ED duration of the participants who provided data at both T1 an T2. This means that patients with a more severe ED in terms of Sensitivity to Punishment and with a “medium” ED duration could have been more motivated compared to patients who relatively recently developed their ED. This is also in line with the finding that ED duration is positively correlated with an individual’s insight in the disorder (Viglione, Muratori, Maestro, Brunori, & Picchi, 2006), although some studies fail to find this association (Konstantakopoulos, Tchanturia, Surguladze, & Davis, 2011).

Regarding the TCI-results, a positive three-way interaction effect of Harm Avoidance, Novelty Seeking and Persistence was found on Body

Dissatisfaction and Bulimic Symptoms. These results suggest that especially high scores on all three traits are the least favourable combination in terms of short-term symptomatic improvement. The finding that the combination of high Harm Avoidance, high Novelty Seeking and high Persistence predicts higher levels of body dissatisfaction and bulimic symptoms, after controlling for the initial level of these symptoms, might be explained by a mediational model. More specifically, the maintenance of bulimic symptoms during an ED course can result from the specific combination of high levels of Harm Avoidance, leading to more feelings of anxiety which can be coped with via binge eating (Tapper, Baker, Jiga-Boy, Haddock, & Maio, 2015), high levels of Novelty Seeking, leading to more approach behaviour towards food (Beaver, Lawrence, van Ditzhuijzen, Davis, Woods, & Calder, 2006) and high levels of Persistence, leading to the persistent repetition of this behaviour (Cloninger, 1987; Cloninger et al., 1993). The maintenance or even increase in bulimic symptoms could in turn maintain body dissatisfaction. Indeed, according to the transdiagnostic model of EDs (Fairburn et al., 2003), bulimic symptoms maintain the over-evaluation of the self in terms of weight and body shape. Although our sample was too small to perform mediation analyses, future research might want to explore this possibility.

Additionally, a significant negative interaction effect between Harm Avoidance and Novelty Seeking on Restrained Eating was found, which confirms the hypothesis that lower levels of Harm Avoidance combined with higher levels of Novelty Seeking predict more decrease in restrained eating.

Taken together, depending on the questionnaire being used, there is mixed evidence that the interaction between several temperament traits may be involved in symptom evolution in patients with a clinical ED. Regarding symptom evolution an sich, it should be noted that, contrary to the expectations, a significant increase in body dissatisfaction was found in the total sample. A possible explanation for this finding is that patients, particularly those with AN-R and AN-B/P, who gain weight at the beginning of therapy, have difficulties coping with this weight gain, resulting in increased body dissatisfaction. This is in line with the finding that initial weight gain in patients with AN results in greater fat mass deposition in the trunk region compared to healthy controls, which normalizes only in the long term (El Choch, Calugi, Lamburghini, & Grave, 2014). Moreover, previous research has already questioned whether body dissatisfaction is integrated enough in therapeutic programs for EDs (Rosen, 1996). For example, Segura-Garcia et al. (2013) did not found a significant change in body dissatisfaction in a five year follow-up study. This may be of particular importance since therapy might confront patients more with their weight, eating behaviour and thoughts about themselves.

The decrease in drive for thinness was not significant. This could be due to the relatively short time span between the first and the second measurement moment and with the small sample size. This non-significant difference between T1 and T2 might have reduced the power to find a predictive effect of temperament on this specific symptom. However, in line with the expectations, a significant decrease in restrained eating and bulimic symptoms was found for patients with AN-B/P, BN and BED and a significant increase in BMI was found for AN-R and AN-B/P patients. This might suggest that behavioural symptoms decrease faster than body dissatisfaction and drive for thinness.

Taken together, this study provides some preliminary evidence that the interaction between several temperament traits might be involved in the course of ED symptoms. Several implications for future research may be derived from these findings. First, it seems relevant to replicate the present study in a larger sample with multiple follow-up moments so that both short and long term symptom improvement can be evaluated. Secondly, examining the evolution of different specific ED symptoms might lead to helpful insights for clinical practice. If indeed some symptoms decrease faster whereas others may increase, it may prove useful to inform patients and their environment about the expected evolution. Moreover, specific research might be conducted regarding the mechanisms explaining why different symptoms may evolve differently, since this might have therapeutic implications.

Based on the small sample size and the fact that few previous research exists on this topic, caution is warranted in drawing clinical conclusions from the present findings. However, these results may suggest that learning to deal with a sensitive temperament could be an important therapeutic target, if future research should confirm the role of temperament in the course of EDs and shed more light on how temperament influences this course.

The present study has several strengths, such as the inclusion of a clinical sample comprising patients with different ED diagnoses and the use of a follow-up design. Moreover, it was attempted to bring a part of the complexity of EDs and their evolution into account by using measures from two models and including interaction terms, rather than only looking at the main effects of simple traits. Also, different ED symptoms were used as outcome measures. However, several limitations have to be noted as well. First, the sample was relatively small, so the findings should be interpreted with caution. Secondly, only self-report questionnaires were used, which might bias the results due to social desirable answers. Also, little information was available regarding the treatment status of the participants between T1 and T2. Whereas most of them were following a CBT-treatment at both measurement moments, some of these patients were no longer in treatment by the second measurement moment. This latter group reported higher levels of several ED symptoms at T2 compared to the subsample of patients who were still in treatment at T2. As such, the intensity and duration of the treatment followed by the different participants and the reasons for not being in treatment any longer at T2 may be important factors to bring into account in future research as they may also be predictive factors, beside temperament, that may have an impact on symptom improvement.

Conclusions

In conclusion, the results so far seem to indicate that the combination of low Harm Avoidance, low Novelty Seeking and low Persistence is predictive for decreases in body dissatisfaction and bulimic symptoms cross-diagnostically. Moreover, the combination of a relative low level of Harm Avoidance and a relative high level of Novelty Seeking is predictive for decreases in restrained eating transdiagnostically. Regarding BMI increases in patients with AN-R or AN-B/P, a higher Sensitivity to Punishment seems to predict a positive evolution in the short term. However, further research is necessary to replicate and expand the present findings.

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Tables

Table 1. Results of the paired samples t-tests regarding symptom change between the first and the second measurement moment.

Diagnostic subsample	Symptom	Mean at T1	Mean at T2	Mean difference	Standard deviation	t(df)
AN-R, AN-B/P, BN, BED (n =58)	Body Dissatisfaction	37.13	41.86	-4.74	8.83	-4.02(55)***
AN-R, AN-B/P, BN, BED (n=58)	Drive for Thinness	32.02	30.61	1.41	8.09	1.30(55)
AN-R, AN-B/P, BN, BED (n=58)	Restrained Eating	3.72	3.48	.23	.86	2.01(54)*
AN-R, AN-B/P, BN, BED (n=58)	Bulimic Symptoms	26.96	18.80	8.16	7.99	7.64(55)***
AN-R, AN-B/P (n=33)	BMI	15.38	16.58	-1.20	2.32	-2.74(27)*

*Note. AN-R = Anorexia Nervosa Restricting Type, AN-B/P = Anorexia Nervosa Binge/Purge Type, BN = Bulimia Nervosa, BED = Binge Eating Disorder, T1 = first measurement moment, T2 = second measurement moment; *p<.05, **p<.01, ***p<.001*

Table 2. Results of the linear regression analyses concerning the predictive effect of temperament on Body Dissatisfaction at T2 in patients with AN-R, AN-B/P, BN and BED.

Dependent variable: Body Dissatisfaction at T2					
	β (SD)	t		β (SD)	t
Step 1: $F(1,46)$=7.76**, Adjusted R^2=.12			**Step 1:** $F(1,53)$=13.35**, Adjusted R^2=.19		
Body Dissatisfaction at T1	.41 (.18)	2.23*	Body Dissatisfaction at T1	.52 (.17)	3.15**
Step 2: $F(2,44)$=.16, R^2 Change=.01			**Step 2:** $F(3,50)$=.57, R^2 Change=.03		
Sensitivity to Punishment	-.28 (1.48)	-.19	Harm Avoidance	.29 (1.60)	.18
Sensitivity to Reward	-.55 (1.41)	-.39	Novelty Seeking	-.48 (1.75)	-.27
			Persistence	-.93 (1.44)	-.65
Step 3: $F(1,43)$=2.09, R^2 Change=.04			**Step 3:** $F(3,47)$=.60, R^2 Change=.03		
Sensitivity to Punishment x Sensitivity to Reward	2.07 (1.44)	1.45	Harm Avoidance x Novelty Seeking	.52 (1.31)	.40
			Harm Avoidance x Persistence	-.03 (1.94)	-.02
			Novelty Seeking x Persistence	.56 (1.24)	.46
			Step 4: $F(1,46)$=7.91**, R^2 Change=.11		
			Harm Avoidance x Novelty Seeking x Persistence	3.90 (1.39)	2.81**

*Note. T2 = second measurement moment, T1 = first measurement moment; *p<.05, **p<.01, ***p<.001*

Table 3. Results of the linear regression analyses concerning the predictive effect of temperament on Drive for Thinness at T2 in patients with AN-R, AN-B/P, BN and BED.

Dependent variable: Drive for Thinness at T2					
	β (SD)	**t**		**β (SD)**	**t**
Step 1: $F(1,46)=13.42$**, Adjusted $R^2=.20$			**Step 1:** $F(1,53)=19.94$***, Adjusted $R^2=.26$		
Drive for Thinness at T1	.57 (.16)	3.66**	Drive for Thinness at T1	.61 (.14)	4.47***
Step 2: $F(2,44)=.22$, R^2 Change=.01			**Step 2:** $F(3,50)=.35$, R^2 Change=.02		
Sensitivity to Punishment	-.25 (1.31)	-.19	Harm Avoidance	-1.22 (1.39)	-.88
Sensitivity to Reward	.81 (1.33)	.61	Novelty Seeking	-1.45 (1.61)	-.90
			Persistence	-.98 (1.37)	-.72
Step 3: $F(1,43)=1.23$, R^2 Change=.02			**Step 3:** $F(3,47)=2.14$, R^2 Change=.09		
Sensitivity to Punishment x Sensitivity to Reward	-1.52 (1.37)	-1.11	Harm Avoidance x Novelty Seeking	-1.62 (1.22)	-1.32
			Harm Avoidance x Persistence	2.05 (1.62)	1.27
			Novelty Seeking x Persistence	1.40 (1.18)	1.18
			Step 4: $F(1,46)=3.34$, R^2 Change=.04		
			Harm Avoidance x Novelty Seeking x Persistence	2.40 (1.31)	1.83

*Note. T2 = second measurement moment, T1 = first measurement moment; *p<.05, **p<.01, ***p<.001*

Table 4. Results of the linear regression analyses concerning the predictive effect of temperament on Restrained Eating at T2 in patients with AN-R, AN-B/P, BN and BED.

Dependent variable: Restrained Eating at T2					
	β (SD)	**t**		**β (SD)**	**t**
Step 1: $F(1,46)$=24.45***, Adjusted R^2=.33			**Step 1:** $F(1,52)$=29.97***, Adjusted R^2=.35		
Restrained Eating at T1	.51 (.11)	4.47***	Restrained Eating at T1	.53 (.11)	5.01***
Step 2: $F(2,44)$=.22, R^2 Change=.01			**Step 2:** $F(3,49)$=.98, R^2 Change=.04		
Sensitivity to Punishment	.08 (.13)	.65	Harm Avoidance	.22 (.14)	1.54
Sensitivity to Reward	.07 (.13)	.51	Novelty Seeking	-.14 (.15)	-.91
			Persistence	-0.7 (.14)	-.51
Step 3: $F(1,43)$=2.47, R^2 Change=.04			**Step 3:** $F(3,46)$=3.73*, R^2 Change=.12		
Sensitivity to Punishment x Sensitivity to Reward	-.21 (.13)	-1.57	Harm Avoidance x Novelty Seeking	-.36 (.11)	-3.18**
			Harm Avoidance x Persistence	-.12 (.16)	-.74
			Novelty Seeking x Persistence	.04 (.11)	.38
			Step 4: $F(1,45)$=2.74, R^2 Change=.03		
			Harm Avoidance x Novelty Seeking x Persistence	.20 (.12)	1.66

*Note. T2 = second measurement moment, T1 = first measurement moment; *p<.05, **p<.01, ***p<.001*

Table 5. Results of the linear regression analyses concerning the predictive effect of temperament on Bulimic Symtoms at T2 in patients with AN-B/P, BN and BED.

Dependent variable: Bulimic Symptoms at T2					
	β (SD)	**t**		**β (SD)**	**t**
Step 1: $F(1,46)=10.45^{**}$, Adjusted $R^2=.17$			**Step 1:** $F(1,53)=14.67^{***}$, Adjusted $R^2=.21$		
Bulimic Symptoms at T1	.62 (.19)	3.23**	Bulimic Symptoms at T1	.67 (.18)	3.83***
Step 2: $F(2,44)=.70$, R^2 Change=.03			**Step 2:** $F(3,50)=1.95$, R^2 Change=.08		
Sensitivity to Punishment	-1.36 (1.32)	-1.03	Harm Avoidance	-.37 (1.28)	-.29
Sensitivity to Reward	.66 (1.32)	.50	Novelty Seeking	.10 (1.52)	.07
			Persistence	-2.49 (1.28)	-1.94^{+}
Step 3: $F(1,43)=.04$, R^2 Change=.00			**Step 3:** $F(3,47)=.63$, R^2 Change=.03		
Sensitivity to Punishment x Sensitivity to Reward	.28 (1.34)	.21	Harm Avoidance x Novelty Seeking	1.21 (1.25)	.97
			Harm Avoidance x Persistence	1.82 (1.61)	1.13
			Novelty Seeking x Persistence	-.10 (1.22)	-.08
			Step 4: $F(1,46)=7.42$, R^2 Change=.09**		
			Harm Avoidance x Novelty Seeking x Persistence	3.55 (1.30)	2.72**

Note. T2 = second measurement moment, T1 = first measurement moment; $^{*}p<.05$, $^{**}p<.01$, $^{***}p<.001$, $^{+}p<.06$

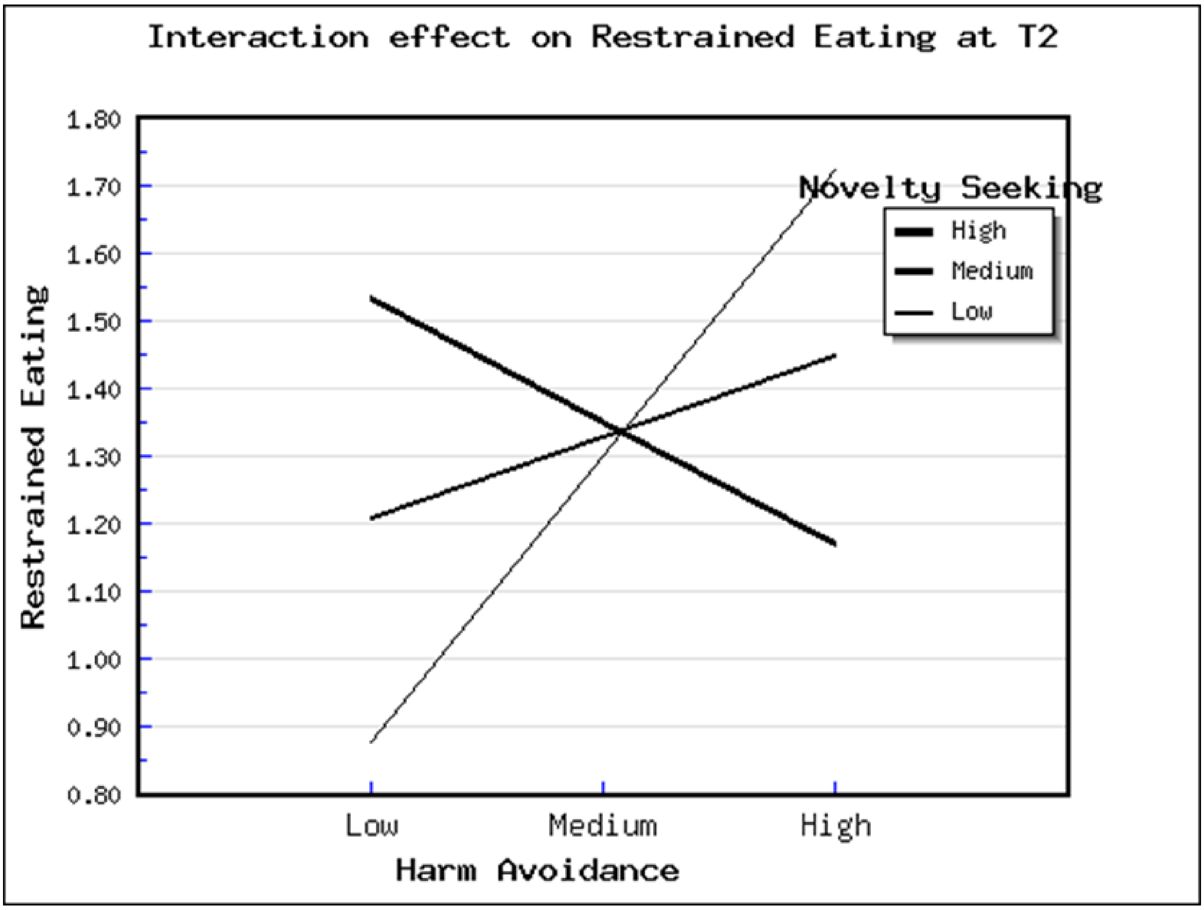
Table 6. Results of the linear regression analyses concerning the predictive effect of temperament on BMI at T2 in patients with AN-R and AN-B/P.

Dependent variable: BMI at T2					
	β (SD)	t		β (SD)	t
Step 1: $F(3,20)$=2.64, Adjusted R^2=.18			**Step 1:** $F(3,23)$=2.62, Adjusted R^2=.16		
BMI at T1	.01 (.28)	.02	BMI at T1	.25 (.28)	.88
Age	-.19 (.11)	-1.75	Age	-.15 (.10)	-1.46
ED duration	.45 (.14)	3.15**	ED duration	.37 (.14)	2.68*
Step 2: $F(2,18)$=3.36$^+$, R^2 Change=.20			**Step 2:** $F(3,20)$=2.45, R^2 Change=.20		
Sensitivity to Punishment	1.27 (.56)	2.26*	Harm Avoidance	1.07 (.79)	1.36
Sensitivity to Reward	.35 (.55)	.64	Novelty Seeking	1.84 (.93)	1.98
			Persistence	.34 (.72)	.47
Step 3: $F(1,17)$=.05, R^2 Change=.00			**Step 3:** $F(3,17)$=.33, R^2 Change=.03		
Sensitivity to Punishment x Sensitivity to Reward	.12 (.57)	.22	Harm Avoidance x Novelty Seeking	.11 (.56)	.21
			Harm Avoidance x Persistence	.52 (.75)	.69
			Novelty Seeking x Persistence	-.19 (1.09)	-.18
			Step 4: $F(1,16)$=.55, p>.05, R^2 Change=.02		
			Harm Avoidance x Novelty Seeking x Persistence	1.23 (1.67)	.74

*Note. T2 = second measurement moment, T1 = first measurement moment, ED = Eating Disorder; *p<.05, **p<.01, ***p<.001*

Figures

Figure 1. The interaction effect between Harm Avoidance and Novelty Seeking on Restrained Eating at T2, after controlling for Restrained Eating at T1.



Chapter 6

Effortful control as a moderator in the association between punishment and reward sensitivity and eating styles in adolescent boys and girls.[5]

Abstract

The reactive traits of Sensitivity to Punishment (SP) and Sensitivity to Reward (SR) are assumed to be involved in the development of Eating Disorders (EDs). Most studies examine whether levels of these traits differ between ED diagnoses, without taking other variables into account. However, vulnerability theories of psychopathology posit that the risk for psychopathology depends on the interaction between reactive traits and self-regulatory traits such as Effortful Control (EC). As such, the present objective was to examine the moderating role of EC in the association between SP, SR and the eating styles restrained eating, emotional eating and external eating as possible ED precursors in adolescents.

To obtain this objective, a community sample of 252 adolescents (54.0% female) between 14 and 19 years old was recruited. Self-report questionnaires were used to measure the level of SP, SR, EC and eating styles. In a subsample (n=46, 67.4% female), the Colour-Word Stroop task was conducted as an additional behavioural measure of EC. Hierarchic linear regressions were performed separately for boys and girls to examine the

[5] Matton, A., Goossens, L., Vervaet, M., & Braet, C. (2017). Effortful Control as a Moderator in the Association between Punishment and Reward Sensitivity and Eating Styles in Adolescent Boys and Girls. *Appetite*, *111*, 177-186. doi: 10.1016/j.appet.2017.01.002

interactions between SP, SR and EC as well as gender differences between these interactions.

There was some evidence for interactions between reactive and regulative traits in explaining restrained and emotional eating in girls. Also, several main effects of SP and SR were found in boys for all eating styles and in girls for restrained eating. The implications of these findings for future research and for screening and prevention programs are discussed.

Introduction

Adolescence is known as a vulnerable period for the development of Eating Disorders (EDs) (Bakalar, Shank, Vannucci, Radin, & Tanofsky-Kraff, 2015; Hoek & Van Hoeken, 2003; Swanson, Crow, Le Grange, Swendsen, & Merikangas, 2011; Waaddegaard, Davidsen, & Kjoller, 2009), which are recognized as persistent disorders with negative consequences on various life domains (Maxwell et al., 2011). As such, increasing scientific insight into vulnerability factors in adolescents is important for screening, prevention and intervention purposes. According to theories considering the vulnerability for psychopathology, the probability of developing a psychological disorder is determined, at least partly, by the interaction between certain reactive temperament traits and self-regulatory capacities (e.g. Lonigan, Vasey, Phillips, & Hazen, 2004; Nigg, 2006). However, to our best knowledge, this interaction between reactive temperament and self-regulatory capacities in the context of ED symptoms has not been examined in adolescents before (Bakalar et al., 2015; Hoek & Van Hoeken, 2003; Swanson et al., 2011; Waaddegaard et al., 2009).

Previous research on the role of temperament in EDs has increasingly focused on the role of reactive approach and avoidance related traits, with several studies supporting the assumption that a vulnerable temperamental profile might increase the risk to develop an ED (Cassin & Von Ranson, 2005; Harrison, O'Brien, Lopez, & Treasure, 2010; Matton, Goossens, Vervaet & Braet, 2015). An important theoretical framework, on which many of these studies are based, is Gray's Reinforcement Sensitivity Theory (RST; Gray, 1970, 1982, 1987; Gray & McNaughton, 2000). According to this theory, human motivation, behaviour and emotion can be explained by the activation of three different brain systems. These are the Behavioural Inhibition System (BIS), the Behavioural Activation System (BAS) and the Fight Flight Freeze system (FFFS). Following the revised RST (Gray &

McNaughton, 2000), the BAS and the FFFS are each other counterparts since these systems are activated by signals of reward versus punishment respectively. The BIS fulfils the role of a conflict detection and resolution system, which is activated whenever competing goals are involved. Based on this theory, the temperament traits of Sensitivity to Punishment (SP) and Sensitivity to Reward (SR) are defined as the reflection of the combined sensitivity of the BIS and the FFFS in the case of SP and as the reflection of the sensitivity of the BAS in the case of SR (Gray, 1970, 1982, 1987; Gray & McNaughton, 2000; Harisson et al., 2010; Matton et al., 2015). Importantly, these traits are assumed to act as vulnerabilities for developing an ED (Harrison et al., 2010; Matton, Goossens, Braet, & Vervaet, 2013; Matton et al., 2015).

Most research on the role of temperament so far focused on clinical samples of ED patients and reports conflicting results, especially regarding the role of SR: some studies suggest that increased SR is specifically related to EDs characterized by binge eating (Harrison et al., 2010; Matton et al., 2015), being Anorexia Nervosa of the Binge/Purge type (AN-B/P), Bulimia Nervosa (BN) and Binge Eating Disorder (BED) (Diagnostic and Statistic Manual of Mental Disorders 5th edition (DSM-V), American Psychiatric Association (APA), 2013) whereas other studies suggest that increased SR is also characteristic of Anorexia Nervosa of the Restricting type (AN-R) (Glashouwer, Bloot, Veenstra, Franken, & de Jong, 2014; Harrison et al., 2010). The finding of high SR being specifically associated with binge/purge EDs in some studies (Harrison et al., 2010; Matton et al., 2015) can be explained by the association between SR and impulsivity (Gray, 1970, 1982, 1987; Gray & McNaughton, 2000) as well as by the assumption that high SR is also translated into high reward sensitivity regarding food stimuli (Vandeweghe, Vervoort, Verbeken, Moens, & Braet, 2016). On the other hand, it has been suggested that not the level of SR but the nature of the stimuli that are experienced as rewarding changes in AN-R patients (Keating, Tilbrook, Rossell, Enticott & Fitzgerald, 2012), which might explain the findings of high SR in AN-R patients that are reported in other studies (Glashouwer, et al., 2014; Harrison et al., 2010). The findings regarding SP are more consistent and generally show heightened levels of SP in ED patients regardless of the specific ED type (Harrison et al., 2010; Matton et al., 2015). From the theoretical perspective that is offered by the RST (Gray, 1970, 1982, 1987; Gray & McNaughton, 2000), it is assumed that increased levels of SP are associated with increased levels of avoidance behaviour and feelings of anxiety, which may result in an ED and in the symptom of restrained eating specifically. In line with this assumption, previous research has shown that high SP is associated with more food-specific avoidance behaviour in children (Vandeweghe et al., 2016).

As previously mentioned, an important limitation is that few studies examined interaction effects, although it is assumed that the influence of SP and SR on ED symptoms will depend on the level of other variables. More specifically, theories considering the vulnerability for psychopathology emphasize the role of self-regulatory processes (e.g. Lonigan, et al., 2004; Nigg, 2006) such as Effortful Control (EC; Rothbart, 1989; Rothbart & Ahadi, 1994) that may influence the association between certain reactive temperament traits and psychopathology (Bijttebier, Beck, Claes, & Vandereycken, 2009). In other words, it is assumed that EC moderates the association between reactive traits and psychopathology in the sense that a high level of EC might help individuals to control their vulnerable temperament which might decrease their risk of developing psychopathology. According to this perspective, it is important to discriminate between executive behavioural inhibition or top-down control versus reactive behavioural inhibition or bottom-up control (Nigg, Silk, Stavro, & Miller, 2005). Whereas the traits defined by the RST refer to bottom-up processes, EC refers to top-down control and reflects self-regulation abilities that develop later in life compared to reactive traits that appear early in life (Claes, Mitchell & Vandereycken, 2012; Nigg et al., 2005). EC consists of the ability to voluntary focus or shift attention (i.e. attention control), the ability to inhibit behaviour (i.e. inhibitory motor control) and the ability to activate behaviour as needed (i.e. activation motor control), which can be measured through observation and self-report questionnaires (Rothbart, 1989; Rothbart & Ahadi, 1994). From the neuropsychological perspective, different tasks have been developed measuring more cognitive aspects of EC, namely the ability to maintain a specific response in the presence of other competing stimuli (i.e. interference control), the ability to exclude mental information from the working memory by actively suppressing it (i.e. cognitive inhibition) and the ability to intentionally delay a motor response (i.e. motor inhibition) (Nigg, 2000; Nigg, et al., 2005).

The hypothesis that EC might moderate the association between reactive traits and psychopathology has already been supported by the results of several studies. For example, in the domain of addiction, it has been shown that the association of SP with alcohol use is indeed moderated by EC, as measured with a neuropsychological task in university students aged 18 to 32 years (Jonker, Ostafin, Glashouwer, van Hemel-Ruiter, de Jong, 2014). More specifically, these authors found that SP was negatively associated with alcohol use, but only when EC was low. In other words, when EC was low the reactive trait SP had more influence on behaviour whereas in the case of high EC, this trait seemed to overrule the influence of SP (Jonker et al., 2014). Another study showed that the association between SR and alcohol use was moderated by EC in pupils from secondary schools aged 14 to 20 years (Willem, Bijttebier, & Claes, 2010). In this study, EC was operationalized by a self-report scale measuring attention, inhibitory and motor control (Willem et al., 2010). Again, the results were in line with the general hypothesis: SR was positively associated with alcohol use, but only in the case of low EC. In the domain of personality disorders, interactions between SP and attention control, measured with a self-report scale, have also been found in an adult sample with a mean age of 37.84 years (Claes, Vertommen, Smits, & Bijttebier, 2009). Again in line with the hypothesis that high EC might overrule the effect of reactive traits on (pathological) behaviour, these authors found that high SP was only related to severe personality disorders if EC was low.

Consistent with these findings, previous research in ED patients has found that high SP was associated with higher probabilities to engage in non suicidal self injury in the presence of low EC (Claes, Norré, Van Assche, & Bijttebier, 2014). Claes, Robinson, Muehlenkamp, Vandereycken, and Bijttebier (2010) also examined the level of EC, measured with both a self-report questionnaire discriminating between the three aspects of EC and with a neuropsychological task measuring interference control, in a clinical sample of ED patients. They found evidence for decreased EC in ED subtypes characterized by binge eating compared to AN-R patients, but the moderating effect of EC on the association of SP and SR with ED symptoms was not examined. In addition, previous research has distinguished three clusters based on SP, SR and EC that were differentially related to symptom severity in patients with an ED (Turner, Claes, Wilderjans, Pauwels, Dierckx, Chapman, & Schoevaerts, 2014), which further supports the idea that all three variables may play an (interactive) role in ED symptoms. Burt, Boddy, and Bridgett (2015) examined the interaction effect between EC, measured with a self-report questionnaire, and the trait negative emotionality on ED symptoms. These researchers found support for the assumption that EC might function as a moderator by showing that the association between negative emotionality and ED symptoms was only significant in the case of low EC. However, they used a convenience sample consisting of (mainly female) psychology students, which limits the generalizability of the results regarding other (age) groups, such as community samples of adolescents.

Taken together, these studies seem to suggest that SP, SR and EC could play an interacting role in the development of EDs, but these possible interaction effects have not been empirically tested so far. Gaining more insight into the role of SP, SR and EC in ED symptoms might have important implications towards prevention and treatment. More specifically, EC is assumed to have a high level of plasticity (Berkman, Graham, & Fisher, 2012), leading to claims that training programs that focus on EC might have good prospects. Therefore, the objective of the present study was to examine the moderating role of EC in the association between SP, SR and ED symptoms in a community sample of adolescents. Both a self-report questionnaire and a neuropsychological measure of EC were used to obtain complementary results. Regarding the neuropsychological testing, in line with Claes et al. (2010), it was chosen to measure interference control by means of the Colour-Word Stroop task. Restrained eating, emotional eating (or eating in response to emotions) and external eating (or eating in response to external triggers) were included as dependent variables as they can be regarded as ED precursors (de Santana, Ribeiro, Giral, & Raich, 2012; Marcus & Kalarchian, 2003; Spoor, Bekker, van Strien, & Van Heck, 2007).

Based on the assumption that SP and SR may be associated with eating styles in adolescents (Matton et al., 2013) and that these traits may not only interact with EC but with each other as well, all two-way interactions as well as the three-way interaction between SP, SR and EC were included in the analyses to test the interaction mechanisms. Similar results were expected regardless of the operationalization of EC (e.g. self-report questionnaire and Colour-Word Stroop task).

Regarding restrained eating, no effect of SR but a positive main effect of SP was expected. This was based on previous findings that SP might be enhanced in patients with an ED while the findings on SR are inconsistent (Harrison et al., 2010; Matton et al., 2015) and on the finding that adolescents with high SP report more restrained eating regardless of the level of SR (Matton et al., 2013). Moreover, the positive association between SP and restrained eating was hypothesized to be weaker in the presence of high EC as well. This is in line with the assumption that high EC might lower the risk for psychopathology in the presence of high SP (Bijttebier, et al., 2009; Claes et al., 2009; Claes et al., 2014; Lonigan, et al., 2004; Nigg, 2006).

Regarding emotional eating, positive main and interaction effects of SP and SR were expected, based on previous findings showing that adolescents with high SP and SR report more emotional eating (Matton et al., 2013). It was also hypothesized that these effects would be more pronounced in the presence of low EC. In other words, high EC was expected to buffer the positive association of high SP and SR with emotional eating.

Regarding external eating, no effect of SP but a positive main effect of SR was expected. This was based on the previous finding that adolescents with high SR report more external eating compared to adolescents with low SR, regardless of the level of SP (Matton et al., 2013). High EC was expected to be associated with less external eating and as such it was hypothesized that the positive association of SR with external eating might decrease in the presence of high EC.

Because gender differences are found in the vulnerability for EDs with higher prevalence rates in girls compared to boys (Smink, van Hoeken, Oldehinkel, & Hoek, 2014), the analyses were performed for boys and girls separately. This is in line with previous research demonstrating gender differences in the associations between reactive and regulative traits and ED symptoms. More specifically, there is some evidence for a stronger and negative association between SR and drive for thinness in boys and for a stronger and negative association between EC and binge/purge symptoms in girls (Kerremans, Claes, & Bijttebier, 2010). However, because few results on male adolescents have been reported so far, no gender-specific hypotheses were formulated, the main goal being to detect possible differences in the mechanisms explaining eating styles in boys versus girls.

Material and Methods

Participants and Procedure

A sample of 252 adolescents (54.0% female) between 14 and 19 years old (M=16.11, SD=1.23) was recruited via Flemish secondary schools. All school principals completed active informed consents. Parents received passive informed consents, informing them about the study and asking them to indicate on the form if they did not want their child to participate. The participants gave written active informed consents and were assured that all data would be handled confidentially. All participants were asked to complete three self-report questionnaires. Of the total sample, 46 participants (67.4% female), who were selected ad random, completed an additional behavioural measure. The participating schools provided 50 minutes in each class to complete the questionnaires, to measure and weigh the participants and to complete the Stroop task. As such, the Stroop task was completed by each fifth student in the class, depending on the size of the class. The completion of the questionnaires and the behavioural task took place during school hours in the presence of a researcher and a teacher. This procedure was approved by the university’s ethic committee.

Measures

Adjusted Body Mass Index (ABMI). Adjusted Body Mass Index (ABMI) was calculated for the participants. The ABMI is based on the Body Mass Index (BMI) as calculated for adults, but corrected for age and gender.

The BMI of the participants is thereby divided by percentile 50 (P50) of the BMI-scores for a specific age and sex. This number is subsequently multiplied by 100, resulting in the ABMI. The P50 is based upon Dutch grow-charts by Fredriks, van Buuren, Wit and Verloove-Vanhorick (2000). An ABMI score equal to or smaller than 85 is considered as underweight, a score equal to or greater than 120 as overweight, and a score equal to or greater than 140 as obese (Van Winckel & Van Mil, 2001).

Sensitivity to Punishment and Sensitivity to Reward Questionnaire. The Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ; Torrubia, Avila, Molto, & Caseras, 2001) was developed to assess the level of SP and SR by a SP- and a SR-subscale (Torrubia et al., 2001) and consists of 44 items to be answered on a five point scale, ranging from ‘never’ to ‘always’. A higher score indicates a higher level of the measured trait. Both the SP- and the SR- subscale consist of 22 items. An example of an item measuring is SP is ‘I avoid demonstrating my skills for fear of being embarrassed’. An item example of the SR scale is ‘The good prospect of obtaining a reward motivates me strongly to do some things’. It has been shown that both scales present satisfactory internal consistency and test-retest reliability as well as convergent and discriminant validity (Torrubia et al., 2001). Cronbach alphas in the current study were .88 for SP and .84 for SR.

Adult Temperament Questionnaire. The Adult Temperament Questionnaire (ATQ; Evans & Rothbart, 2007) was developed to measure several temperament constructs. In the present study, only the three scales measuring the construct of EC were included. These scales are attention control (five items), inhibitory control (seven items) and activation control (seven items). The items are answered on a seven point scale ranging from ‘not at all true’ to ‘completely true’. We opted for the ATQ instead of the Early Adolescent Temperament Questionnaire Revised (EATQ-R; Ellis & Rothbart, 2005) since the EATQ-R questionnaire was developed for younger participants between 9 and 15 years. An item example for attention control is 'I find it hard to switch between different tasks' (reverse scored), an example for inhibitory control is 'It is easy for me to hold back my laughter in a situation where it is not appropriate', and an example for activation control is 'I hardly ever finish things on time' (reverse scored). Cronbach alphas in the present study were .35 for attention control, .48 for inhibitory control and .61 for activation control. For the total EC scale, which was used in the following analyses and which comprises the scores on all three subscales, Cronbach alpha was .70. This total EC score based on the three EC subscales of the ATQ will be further referred to as the self-reported EC-total score.

Stroop Task. The Stroop Task or Colour-Word Interference test (Stroop, 1935) was developed to measure the ability to inhibit a more automatic response in favour of a conflicting response (i.e. interference control) (MacLeod, 1991). The Stroop task as used in the present study consists of three conditions. In the first condition, the participant is asked to name the colour of different coloured rectangles presented in rows on a white stimulus card. During the second condition, the participant is asked to read words indicating colours out loud. Similar to the presentation of the colours, the words are presented (in black) in rows on a white stimulus card. In the third condition, a similar stimulus card is presented containing words that refer to colours but which are printed in another colour than the colour they refer to. The participant is asked to suppress his/her automatic response (i.e. reading the words referring to colours) and to give a conflicting response (i.e. naming the colour in which the word is printed). During all three conditions, the researcher registers the time needed to complete the condition, the number of corrected mistakes and the number of uncorrected mistakes. If the participant makes four uncorrected mistakes or if the time needed exceeds 90 sec. in condition 1 or condition 2 or if the time needed exceeds 180 sec. in condition 3, the task is stopped by the researcher. The stimulus cards are presented in front of the participant on a table. The instructions are given to the participant after the stimulus card has been presented. The interference score on the Stroop task was obtained by first calculating the scaled scores (M=10, SD=3) on each of the three conditions based on the time needed to finish each condition. Next, the contrastscore was calculated by subtracting the scaled score of condition 3 from the scaled score of condition 1. A higher contrastscore is then indicative of a higher level of interference control. The Stroop task has shown to be a valid task in previous research concerning EC and EDs (e.g. Claes, et al., 2012; Claes, et al., 2010). The score on the Stroop task will be further referred to as interference control.

Dutch Eating Behaviour Questionnaire. The Dutch Eating Behaviour Questionnaire (DEBQ; van Strien et al., 1986) was developed to measure three different eating styles and contains 33 items, divided into the subscales restrained eating (10 items), emotional eating (10 items) and external eating (13 items). The items have to be answered on a five point scale, ranging from 'never' to 'very often'. A higher score indicates a higher level of the specific eating style that is measured. An item example of restrained eating is 'Do you sometimes refuse offered food or drinks because of your weight?'. An example of an item measuring emotional eating is 'Do you feel like eating when you are upset?' and an item example of external eating is 'Do you feel like eating something, when you see or smell something good?'. The DEBQ has high internal consistency and factorial validity (Van Strien et al., 1986). Cronbach alpha in the current study was .94 for restrained eating, .92 for emotional eating and .75 for external eating.

Data Analytic Plan

First, it was examined whether all variables under study were normally distributed, which was confirmed based on the Kolmogorov-Smirnov test. Moreover, independent samples t-tests were conducted to compare the subsample that completed both the ATQ and the Stroop task with the sample completing only the ATQ on the dependent and the independent variables under study. Also, the pearson correlation between self-reported EC-total and interference control was calculated.

Secondly, gender differences in the (in)dependent variables SP, SR, self-reported EC-total, interference control, restrained eating, emotional eating and external eating were examined. In addition, the associations between the temperament variables and the eating styles were examined for boys and girls separately as well as the associations between age, ABMI, and the dependent variables.

Next, six hierarchic linear regression analyses were performed for boys and girls separately with restrained, emotional and external eating as dependent variables and with self-reported EC-total and interference control as moderators. To compute interaction terms, the independent variables were first standardized. In the first step of the analysis, the control variable ABMI was included if the correlation analysis revealed a significant association with the dependent variable under study (see preliminary results section). In the second step, the standardized scores on SP, SR and self-reported EC-total or interference control were included. In the third step, the two-way interaction terms between SP, SR and self-reported EC-total or interference control were added. The three-way interaction between SP, SR and self-reported EC-total or interference control was added in the fourth and final step.

Results

Descriptives

The sample completing the Stroop task (n=46) did not differ significantly from the sample not completing the Stroop task (n=206) on SP ($t(247)=-1.24$, $p>.05$), SR ($t(58.16)=-1.27$, $p>.05$), self-reported EC-total

($t(246)=-.40$, $p>.05$), restrained eating ($t(239)=-1.54$, $p>.05$), emotional eating ($t(239)=-1.27$, $p>.05$) or external eating ($t(239)=-1.27$, $p>.05$).

No significant association was found between self-reported EC-total and interference control measured with the Stroop task ($r=-.07$, $p>.05$).

Significant gender differences were found with girls (n=136) scoring higher than boys (n=116) on SP, restrained eating, emotional eating and external eating, while the opposite was found for SR. Moreover, a marginally significant gender difference was found on self-reported EC-total score, with girls tending to score lower than boys. On the other hand, no gender differences were found regarding the level of interference control (see Table 1).

In both boys and girls, SP was significantly and positively correlated with restrained and emotional eating, while SR was significantly and positively correlated with emotional and external eating. A significant negative association between self-reported EC-total and emotional eating was found for both boys and girls and an additional significant negative association between self-reported EC-total and external eating was found in girls. Interference control was not associated with any of the eating styles (see Table 2).

Age did not correlate with any of the eating styles in both boys and girls. ABMI ranged from 74.65 to 153.00 (M=104.24; SD=14.83) and was significantly and positively associated with restrained eating in both boys ($r=.46$, $p<.001$) and girls ($r=.29$, $p<.01$). ABMI was also significantly and negatively associated with external eating in both boys ($r=-.26$, $p<.05$) and girls ($r=-.25$, $p<.05$). No correlation between ABMI and emotional eating was found. Based on these results, ABMI was included as a control variable in the first step of the regression analyses with restrained or external eating as dependent variables, but not in analyses regarding emotional eating.

The mean scores on time needed to finish each condition of the Stroop task as well as the mean number of corrected and uncorrected mistakes for each condition are reported in Table 3.

The Role of SP, SR and EC for Restrained Eating

Self-reported EC-total as a Moderator in Boys. The first model, with ABMI as a control variable, was significant with $F(1,96)=23.88$, $p<.001$, adjusted $R^2=.19$. The second model, adding SP, SR and self-reported EC-total, significantly improved the first model, with $F(3,93)=2.93$, $p<.05$, R^2 change=.07. The third model, adding the two way interaction effects, did not significantly improve the second model, with $F(3,90)=.49$, $p>.05$, R^2 change=.01. The fourth model, adding the three way interaction effect between SP, SR and self-reported EC-total, did not improve the third model, with $F(1,89)=.15$, $p>.05$, R^2 change=.00. A positive main effect of ABMI and of SR were found (see Table 4).

Self-reported EC-total as a Moderator in Girls. The first model, with ABMI as a control variable, was significant with $F(1,94)=7.31$, $p<.01$, adjusted $R^2=.06$. The second model, adding SP, SR and self-reported EC-total, significantly improved the first model with $F(3,91)=5.85$, $p<.01$, R^2 change=.15. The third model, adding the two way interaction effects, and the fourth model, adding the three way interaction effect, were no significant improvements to the former models, with $F(3,88)=1.29$, $p>.05$, R^2 change=.03 and $F(1,87)=.03$, $p>.05$, R^2 change=.00 respectively. A positive main effect of ABMI and of SP were found (see Table 4).

Interference Control as a Moderator in Boys. The first model, including ABMI as a control variable, was significant with $F(3,13)=4.83$, $p<.05$, adjusted $R^2=.22$. The second model, adding SP, SR and interference control, did not significantly improve the first model, with $F(3,10)=2.45$, $p<.05$, R^2 change=.31. Also the third and fourth model, adding the two way and three way interaction terms respectively, were no significant improvements to the former models, with $F(3,7)=.74$, $p>.05$, R^2 change=.10 for the third model and $F(1,6)=2.34$, $p>.05$, R^2 change=.09 for the fourth model. Based on the first and significant model, a positive main effect of ABMI was found. The second model also revealed a significant positive main effect of SR (see Table 5).

Interference Control as a Moderator in Girls. The first model, with ABMI as control variable, was not significant with $F(1,26)=3.18$, $p>.05$, adjusted $R^2=.08$. The second model, adding SP, SR and interference control to the model, significantly improved the first model with $F(3,23)=3.30$, $p<.05$, R^2 change=.27. The third model, adding the two way interaction effects, did not improve the second model, with $F(3,20)=1.67$, $p>.05$, R^2 change=.12. The fourth model however, adding the three way interaction effect between SP, SR and interference control, significantly improved the third model, with $F(1,19)=8.13$, $p<.05$, R^2 change=.15. Based on the significant fourth model, a positive main effect of SR was found, as well as a negative interaction effect between SP and interference control (see Figure 1), a positive interaction effect between SR and interference control (see Figure 2) and a negative interaction effect between SP, SR and interference control (see Table 5). To interpret the negative three way interaction effect, the scores on SP were reversed, based on the finding of a negative interaction effect between SP and interference control. The results then showed a positive interaction effect between SP-reversed, SR and interference control ($B(2.92)=8.33$, $p>.05$), implying that restrained eating was positively associated with a combination of low SP, high SR and high interference control.

The Role of SP, SR and EC for Emotional Eating

Self-reported EC-total as a Moderator in Boys. The first model, including SP, SR and self-reported EC-total as predictors, was significant with $F(3,108)=6.31$, $p<.01$, adjusted $R^2=.13$. The second model adding the two way interaction effects between the independent variables did not significantly improve the first model, with $F(3,105)=2.47$, $p>.05$, R^2 change = .06, nor did the third model adding the three way interaction term, with $F(1,104)=.20$, $p>.05$, R^2 change = .00. Based on the first and significant model, a significant positive main effect of SP was found (see Table 6).

Self-reported EC-total as a Moderator in Girls. The first model, including SP, SR and self-reported EC-total, was significant with $F(3,121)=4.26$, $p<.01$, adjusted $R^2=.07$. The second model, adding the two way interaction effects, significantly improved the first model, with $F(3,118)=3.60$, $p<.05$, R^2 change=.08. Adding the three way interaction effect in the third model did not significantly improve the second model, with $F(1,117)=.02$, $p>.05$, R^2 change=.00. A positive main effect of SP was found, as well as a positive interaction effect of SP and self-reported EC-total (see Table 6 and Figure 3).

Interference Control as a Moderator in Boys. None of the models was significant, with $F(3,11)=1.71$, $p>.05$, adjusted $R^2=.13$ for the first model including SP, SR and interference control, with $F(3,8)=.90$, $p>.05$, R^2 change=.17 for the second model, adding the two way interaction effects, and with $F(1,7)=.76$, $p>.05$, R^2 change=.05 for the third model, adding the three way interaction effect. The coefficients and t-tests for each of the predictors are presented in Table 7.

Interference Control as a Moderator in Girls. None of the models was significant, with $F(3,24)=1.79$, $p>.05$, adjusted $R^2=.08$ for the first model including SP, SR and interference control, with $F(3,21)=.40$, $p>.05$, R^2 change=.04 for the second model, adding the two way interaction effects, and with $F(1,20)=2.68$, $p>.05$, R^2 change=.32 for the third model, adding the three way interaction effect. The coefficients and t-tests for each of the predictors are presented in Table 7.

The role of SP, SR and EC for External Eating

Self-reported EC-total as a Moderator in Boys. The first model, with ABMI as a control variable, was significant with $F(1,96)=6.84$, $p<.05$, adjusted $R^2=.06$. The second model, adding SP, SR and self-reported EC-total, significantly improved the first model with $F(3,93)=3.60$, $p<.05$, R^2 change=.10. The third model, adding the two way interaction effects, and the fourth model, adding the three way interaction effect, did not significantly improve the former models with $F(3,90)=1.29$, $p>.05$, R^2 change=.04 and $F(1,89)=1.80$, $p>.05$, R^2 change=.02 respectively. A negative main effect of ABMI and a positive main effect of SR were found (see Table 8).

Self-reported EC-total as a Moderator in Girls. The first model, including ABMI as control variable, was significant with $F(1,94)=6.64$, $p<.05$, adjusted $R^2=.06$. The second model, adding SP, SR and self-reported EC-total, significantly improved the first model with $F(3,91)=3.87$, $p<.05$, R^2 change=.11. The third model, adding the two way interaction effects, and the fourth model, adding the three way interaction effect, were no significant improvements to the former models, with $F(3,88)=.29$, $p>.05$, R^2 change=.01 and $F(1,87)=.67$, $p>.05$, R^2 change=.01 respectively. A negative main effect of ABMI and of self-reported EC-total were found (see Table 8).

Interference Control as a Moderator in Boys. The first model, with ABMI as a control variable, was marginally significant with $F(1,13)=4.59$, $p<.06$, adjusted $R^2=.20$. The second model, adding SP, SR and interference control, significantly improved the first model with $F(3,10)=6.61$, p<.05, R^2 change=.49. The third and fourth model, adding the two way and three way interaction effects respectively, were no significant improvements to the former models with $F(3,7)=.69$, $p>.05$, R^2 change=.06 for the third model and $F(1,6)=.07$, $p>.05$, R^2 change=.00 for the fourth model. Based on the first model, a marginally significant negative main effect of ABMI was found.

Based on the significant second model, a positive main effect of SR was found (see Table 9).

Interference Control as a Moderator in Girls. None of the models was significant, with $F(1,26)=1.42$, $p>.05$, adjusted $R^2=.02$ for the first model including ABMI, $F(3,23)=.46$, $p>.05$, R^2 change=.05 for the second model adding SP, SR and interference control, $F(3,20)=.05$, $p>.05$, R^2 change=.01 for the third model adding the two way interaction effects, and $F(1,19)=2.20$, $p>.05$, R^2 change=.09 for the fourth model adding the three way interaction effect. The coefficients and t-tests for each of the predictors are presented in Table 9.

Discussion

Based on the accumulating evidence that SP and SR play a role in EDs (Harrison, 2010; Matton et al., 2013; 2015) and the current theoretical perspective that the interaction between certain reactive temperament traits and self-regulatory capacities may increase or decrease the risk for psychopathology (e.g. Lonigan, et al., 2004; Nigg, 2006), the objective of the present study was to examine the moderating role of EC in the association between SP, SR and restrained, emotional and external eating, thereby controlling for current ABMI. The focus of this study was on adolescent boys and girls since this is a group at risk for the development of an ED (Bakalar, et al., 2015; Hoek & Van Hoeken, 2003; Swanson, et al., 2011; Waaddegaard, et al., 2009).

First, regarding restrained eating, ABMI seemed to positively predict higher levels of this behaviour in both boys and girls, which is in line with previous results (Snoek, van Strien, Janssens, & Engels, 2008). On the other hand, gender differences were found in the role of SP, SR and EC in restrained eating. In boys, contrary to the expectations, especially high SR, instead of high SP, was positively associated with restrained eating. When looking at which items of the SR-subscale of the SPSRQ show a positive correlation with restrained eating in boys, it seems that the items referring to social forms of reward in particular are associated with higher levels of restrained eating. For example, the items ‘I spend a lot of time on getting a good image’ and ‘I often do things to get other’s approval’ were significantly and positively correlated with restrained eating. This might imply that boys who are sensitive to social reward are more likely to adapt their eating behaviour. Possible explanations are that these boys may be more sensitive for media influence and may want to look more like same-sex figures (Field, Camargo, Taylor, Berkey, Roberts, & Colditz, 2001). Contrary to the expectations, no interaction effects between SP, SR and EC were found in boys for explaining restrained eating. In girls on the other hand, evidence was found for a positive association between SP and restrained eating, which was in line with the expectations (Harrison et al., 2010; Matton et al., 2013; 2015), but only when self-reported EC-total was included as a moderator. In models with interference control as a moderator, this variable interacted with both SP and SR in explaining the level of restrained eating in girls. First, high SP was associated with more restrained eating in the presence of low interference control, but not in the presence of high interference control. This is in line with the hypothesis that high EC might function as a protective factor in the presence of vulnerability factors (Bijttebier, et al., 2009; Claes et al., 2009; Claes et al., 2014; Lonigan, et al., 2004; Nigg, 2006). In addition, high SR was associated with more restrained eating, especially in the case of high interference control. A possible explanation is that high SR motivates individuals to eat more since food is experienced as more rewarding by them (Beaver, Lawrence, van Ditzhuijzen, Davis, Woods, & Calder, 2006; Shin, Zheng, & Berthoud, 2009). High levels of interference control might help people to inhibit this tendency, whereas individuals with low interference control might not have the necessary ‘brake’ to inhibit their approach tendencies towards food. In line with the finding that, also in girls, items related to social reward seemed to correlate with restrained eating, this could imply that restrained eating is facilitated by high interference control in adolescents who are sensitive to social reward and/or who are motivated to lose weight due to overweight or body dissatisfaction and experience this as a long term reward.

A third significant interaction effect was also found between SP, SR and interference control, indicating that a combination of low SP, high SR and high interference control was positively associated with restrained eating. This is in line with the finding that in the case of low SP restrained eating is higher when EC is also high, and that high SR is associated with more restrained eating when EC is high. It should be noted however, that these interaction effects were not found for self-reported EC-total. This could imply that different aspects of EC may play different roles in the explanation of restrained eating. On the other hand, it should be kept in mind that interference control was only measured in a small subsample, and as such the results should be interpreted with caution. Moreover, mixed results have been found in previous studies on the level of interference control in patients with a restrictive versus a binge/purge ED: both a higher level of interference control in restrictive ED patients compared to binge/purge ED patients has been found (Claes et al., 2010), as well as equal levels of interference control between both ED subtypes (Claes et al., 2012).

Secondly, regarding emotional eating, a positive association with SP was found in boys, which was in line with the expectations (Matton et al., 2013). In girls, a positive interaction effect between SP and self-reported EC-total was found, implying that there was a positive association between SP and emotional eating in the presence of high self-reported EC. This is in contradiction with the expectation of the buffering effect of EC (Bijttebier, et al., 2009; Claes et al., 2009; Claes et al., 2014; Lonigan, et al., 2004; Nigg, 2006), but is in line with the finding of Jonker et al. (2014) that in some cases low instead of high EC is protective, as well as with previous findings regarding depression in adolescents, indicating that high cognitive control, as an aspect of EC, might function as a risk factor for psychopathology (Wante, Mueller, Demeyer, De Raedt, & Braet, 2016). One perspective on these findings could be that emotional eating is enhanced in girls with high SP, referring to enhanced feelings of anxiety to cope with, but also in girls high in EC trying to control their behaviour. More research is needed to clarify these findings. However, it seems possible that high EC is not always a protective factor.

Regarding external eating, a positive association with ABMI was found in both sexes, in line with previous findings (Braet, Claus, Goossens, Moens, Van Vlierberghe, & Soetens, 2008). Again, some gender differences rose, showing that SR was positively associated with external eating in boys, which is in line with the expectations (Matton et al., 2013). In girls, self-reported EC-total was negatively associated with external eating indicating that high EC might buffer external eating girls, which was also as expected.

In conclusion, the present study found additional evidence for the assumption of earlier studies that both reactive and regulative traits may play a role in eating behaviour (Burt, et al., 2015; Claes, et al., 2014 ; Claes, et al., 2010; Turner, et al., 2014). However, contrary to the expectations, only few significant interactions between reactive and regulative traits were found. Further research, discriminating between more different aspects of EC, might be necessary to enhance our insight in the assumed interplay between SP, SR and EC. For example, high activation control might be protective for the development of restrained eating, since this eating style is characterized by inhibitory behaviour, whereas high inhibitory control might be protective for the development of emotional and external eating since these eating styles are characterized by enhanced approach behaviour towards food.

It should also be noted that some important gender differences were found. Previous studies already showed that girls are more vulnerable to develop EDs (Smink et al., 2014) and also score higher on SP and lower on SR compared to boys (Matton et al., 2013), which was replicated here. In addition, based on the present finding that significant interactions between SP, SR and EC were only found in girls, it is possible that different developmental pathways may apply to boys versus girls. One possibility is that, in girls, EC may play a more important role in their eating behaviour compared to boys. However, few studies have reported results on the role of temperament in eating behaviour for boys and girls separately, so more research is necessary to test this assumption.

This study has several strengths. First, although recent theories emphasize the importance of the interaction between reactive traits and self-regulatory capacities to understand psychopathology (e.g. Lonigan, et al., 2004; Nigg, 2006), to our best knowledge, this is the first study to examine the interaction between SP, SR and EC for the explanation of eating styles as possible ED precursors in an adolescent community sample. This is important because adolescents are a group at risk for the development of EDs and the present results may guide further research that might identify groups at risk and could be helpful for the development of screening and prevention programs. The inclusion of both boys and girls also allows discriminating gender specific effects. Furthermore, EC was measured using two different methods: a self-report questionnaire versus a neuropsychological task.

However, some limitations should also be noted. First, although the internal consistency of the total EC-scale of the ATQ was sufficient, the internal consistency of the EC-subscales was insufficient. Since the internal consistency of the other self-report scales in the study was good, is seems that this was not a general sample effect. Previous research with the ATQ reported a sufficient internal consistency for the total EC-scale (Burt et al., 2015; de

Zwaan, Engeli, & Müller, 2015) as well as for the separate subscales, with Cronbach's alphas between .69 and .74 for the three subscales (Claes, et al., 2010). However, these studies involved older adolescents or adults, so the lower internal consistency found in the present study for the three EC-subscales might be an effect of age. This is consistent with the finding of sufficient internal consistency of the EATQ-r in an adolescent sample with an age range of 14 to 19 years (Baetens, Claes, Willem, Muehlenkamp, & Bijttebier, 2011). Secondly, the self-reported EC-total score was not correlated with interference control measured with the Stroop task. Although a positive association between both instruments could be expected from a theoretical point of view, previous studies also failed to show a correlation between self-report measures of EC and neuropsychological measures of EC (Claes, Nederkoorn, Vandereycken, Guerrieri, & Vertommen, 2006; Janis & Nock, 2009; Verstraeten,Vasey, Claes, & Bijttebier, 2010), indicating that this might not be a study specific limitation but a limitation of the available instruments. A third limitation is that the number of participants who completed the Stroop task was relatively low, which has implications for the power of the analyses regarding interference control. An additional limitation related to the Stroop task is that the time needed by the participants to read the cards was measured with a chronometer and not with a computer, which implies a lower accurateness. For these reasons, it is important for future research to replicate the present findings in larger samples. Moreover, since the cross-sectional nature of the present study does not allow causal conclusions, longitudinal studies should be conducted, to examine whether an interaction between SP, SR and EC predicts the development of EDs. It also seems relevant to test these interactions in clinical populations, to examine whether they are of specific importance before the onset of a full-blown ED, whether they also play a maintaining role during the course of an ED and whether they can be observed in patients after recovery. Bringing moderators, such as EC, into account in clinical samples might also increase our insight into the complex role of different temperamental factors as well as provide explanations for the inconsistent findings of SR in clinical populations. As previously mentioned, it will also be important to expand our knowledge regarding which aspects of EC are of specific relevance to which ED symptoms. This might hold important implications for training programs aimed at enhancing (or decreasing) certain aspects of EC.

If replicated, the current results may contain important implications towards ED screening and prevention. More specifically, in screening procedures it might be important to bring vulnerable personality profiles into account, since it seems that, especially in girls, specific combinations of SP, SR and EC may increase the risk to develop certain eating styles. Moreover, if self-regulatory capacities enhance or decrease the risk to develop an ED in girls, depending on the level of SP and SR, training of these capacities might be important in prevention and possibly treatment programs.

In conclusion, some tentative evidence was found for an interaction between reactive and regulative traits in explaining restrained and emotional eating in girls, however further research is needed to clarify and expand these results. The present findings also suggest that several gender differences may exist in the role of SP, SR and EC in the development of specific eating styles. If replicated, these findings hold different implications for screening and prevention in boys versus girls.

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Tables

Table 1. Mean scores and independent samples t-test for boys and girls on the dependent and independent variables.

	Boys M (SD)	Girls M (SD)	t (df)
SP	55.08 (10.90)	61.40 (13.59)	-4.07 (245.92)***
SR	66.71 (10.59)	61.49 (10.29)	3.94 (248)***
Self-reported EC-total	80.39 (11.20)	77.38 (12.72)	1.96 (246)$^{+}$
Interference control	-9.59 (2.00)	-10.20 (3.39)	.64 (44)
Restrained eating	19.11 (7.86)	23.42 (9.58)	-3.83 (237.79)***
Emotional eating	25.28 (10.19)	32.28 (10.75)	-5.17 (239)***
External eating	29.32 (6.09)	31.04 (5.47)	-2.31 (239)*

*Note. M = Mean, SD = Standard Deviation, SP = Sensitivity to Punishment, SR = Sensitivity to Reward, EC = Effortful Control; *p<.05, **p<.01, ***p<.001, $^{+}$marginally significant (p<.06)*

Table 2. Correlations between the independent and the dependent variables for boys and girls separately.

	Boys (n=116)[1]			Girls (n=136)[1]		
	Restrained eating	Emotional eating	External eating	Restrained eating	Emotional eating	External eating
SP	.21*	.34**	.01	.37***	.22*	.03
SR	.17	.22*	.34***	-.06	.25**	.38***
Self-reported EC-total	-.18	-.19*	-.16	.04	-.24**	-.28**
Interference control	-.11	.02	.07	-.30	-.28	.01

*Note. 1For interference control the sample size was equal to n=15 for boys and to n=31 for girls; SP = Sensitivity to Punishment, SR = Sensitivity to Reward, EC = Effortful Control; *p<.05, **p<.01, ***p<.001*

Table 3. Mean results on the Stroop task (n= 46).

	Condition 1 M (SD)	Condition 2 M (SD)	Condition 3 M (SD)
Time in seconds	42.62 (5.87)	33.48 (4.64)	64.76 (11.05)
Corrected mistakes	.72 (1.00)	.24 (.52)	1.54 (1.44)
Uncorrected mistakes	.09 (.28)	.02 (.15)	.33 (.70)

Note. Condition 1 = naming colours, Condition 2 = reading words referring to colours out loud, Condition 3 = naming the colour in which a word referring to another colour is printed.

Table 4. Results of the regression analysis regarding the moderating role of self-reported EC-total in the association of SP and SR with restrained eating in boys and girls.

	Restrained eating			
	Boys		Girls	
	B (SE)	t	B (SE)	t
ABMI	.23 (.05)	4.89***	.17 (.06)	2.70**
SP	.82 (.83)	.99	3.29 (.81)	4.06***
SR	1.70 (.75)	2.28*	.27 (1.03)	.26
Self-reported EC-total	-.23 (.73)	-.32	-.49 (.96)	-.52
SPxSR	-.40 (.72)	-.56	-.35 (1.26)	-.28
SPxself-reported EC-total	-1.12 (.97)	-1.15	1.47 (.96)	1.53
SRxself-reported EC-total	-.08 (.69)	-.12	.13 (.97)	.13
SPxSRxself-reported EC-total	-.32 (.82)	-.39	-.23 (1.44)	-.16

*Note. ABMI = Adjusted Body Mass Index, SP = Sensitivity to Punishment, SR = Sensitivity to Reward, EC = Effortful Control; *p<.05, **p.01, ***p<.001*

In boys, only model 1 and model 2 were significant (p<.001 and p<.05 respectively), in girls also model 1 and model 2 were significant (p<.01).

Table 5. Results of the regression analysis regarding the moderating role of interference control in the association of SP and SR with restrained eating in boys and girls.

	Restrained eating			
	Boys		Girls	
	B (SE)	t	B (SE)	T
ABMI	.27 (.12)	2.20*	.07 (.09)	.86
SP	-2.40 (1.71)	-1.41	1.52 (1.44)	1.05
SR	3.95 (1.62)	2.45*	4.08 (1.41)	2.89**
Interference control	-.2.00 (2.46)	-.81	.55 (1.44)	.38
SPxSR	1.18 (1.63)	.73	-2.37 (1.84)	-1.28
SPxinterference control	-.61 (2.69)	-.23	-6.91 (2.24)	-3.09**
SRxinterference control	6.03 (5.11)	1.18	6.64 (2.00)	3.32**
SPxSRxinterference control	12.89 (8.43)	1.53	-7.84 (2.75)	-2.85*

*Note. ABMI = Adjusted Body Mass Index, SP = Sensitivity to Punishment, SR = Sensitivity to Reward; *p<.05, **p.01, ***p<.001*

In boys, only model 1 was significant (p<.05), in girls model 2 and model 4 were significant (p<.05).

Table 6. Results of the regression analysis regarding the moderating role of self-reported EC-total in the association of SP and SR with emotional eating in boys and girls.

	Emotional eating			
	Boys		Girls	
	B (SE)	t	B (SE)	T
SP	3.61 (1.08)	3.33**	1.90 (.88)	2.17*
SR	1.52 (.95)	1.60	2.13 (1.15)	1.86
Self-reported EC-total	-.97 (.93)	-1.04	-.75 (1.03)	-.73
SPxSR	1.03 (.95)	1.08	-.59 (1.22)	-.49
SPxself-reported EC-total	-.66 (1.23)	-.54	2.23 (.88)	2.54*
SRxself-reported EC-total	1.71	.84	-1.36 (.96)	-1.42
SPxSRxself-reported EC-total	-.46 (1.03)	-.45	.14 (1.00)	.14

*Note. SP = Sensitivity to Punishment, SR = Sensitivity to Reward, EC = Effortful Control; *p<.05, **p.01, ***p<.001*

In boys only model 1 was significant (p<.01), in girls model 1 and model 2 were significant (p<.01 and p<.05 respectively).

Table 7. Results of the regression analysis regarding the moderating role of interference control in the association of SP and SR with emotional eating in boys and girls.

	Emotional eating			
	Boys		Girls	
	B (SE)	t	B (SE)	T
SP	2.02 (1.82)	1.11	2.58 (2.20)	1.17
SR	2.49 (1.63)	1.53	1.30 (2.10)	.62
Interference control	.24 (.87)	.28	-.44 (2.04)	-.22
SPxSR	-.92 (1.57)	-.59	-1.39 (2.79)	-.50
SPxinterference control	-3.37 (2.35)	-1.44	-4.30 (3.07)	-1.40
SRxinterference control	4.16 (4.55)	.91	5.51 (2.98)	1.85
SPxSRxinterference control	-8.50 (9.75)	-.87 (.41)	-6.62 (4.05)	-1.64

*Note. SP = Sensitivity to Punishment, SR = Sensitivity to Reward; *p<.05, **p.01, ***p<.001*
In boys and girls, none of the models was significant.

Table 8. Results of the regression analysis regarding the moderating role of self-reported EC-total in the association of SP and SR with external eating in boys and girls.

	External eating			
	Boys		Girls	
	B (SE)	t	B (SE)	T
ABMI	-.10 (.04)	-2.62*	-.09 (.04)	-2.58*
SP	-.00 (.70)	-.00	.11 (.47)	.24 (.81)
SR	1.96 (.63)	3.13**	.86 (.59)	1.45
Self-reported EC-total	.17 (.62)	.28	-1.10 (.55)	-2.00*
SPxSR	.71 (.60)	1.19	-.15 (.74)	-.20
SPxself-reported EC-total	-.25 (.81)	-.31	-.20 (.56)	-.36
SRxself-reported EC-total	.57 (.58)	.98	-.45 (.57)	-.79
SPxSRxself-reported EC-total	-.91 (.68)	-1.34	.68 (.84)	.82

*Note. ABMI = Adjusted Body Mass Index, SP = Sensitivity to Punishment, SR = Sensitivity to Reward, EC = Effortful Control; *p<.05, **p.01, ***p<.001*

In boys and in girls, model 1 and model 2 were significant (p<.05).

Table 9. Results of the regression analysis regarding the moderating role of interference control in the association of SP and SR with external eating in boys and girls.

	External eating			
	Boys		Girls	
	B (SE)	t	B (SE)	T
ABMI	-.20 (.10)	-2.14+	-.09 (.06)	-1.49
SP	-1.17 (1.02)	-1.16	.15 (1.05)	.14
SR	4.15 (.96)	4.32**	1.28 (1.03)	1.25
Interference control	1.98 (1.46)	1.36 (.20)	.84 (1.05)	.80
SPxSR	.60 (.97)	.62	-.71 (1.34)	-.53
SPxinterference control	.44 (1.61)	.27	-1.91 (1.63)	-1.17
SRxinterference control	-3.97 (3.06)	-1.30	1.84 (1.46)	1.26
SPxSRxinterference control	1.51 (5.92)	.26	-2.97 (2.00)	-1.48

*Note. ABMI = Adjusted Body Mass Index, SP = Sensitivity to Punishment, SR = Sensitivity to Reward; *p<.05, **p.01, ***p<.001, +marginally significant (p<.06).*

In boys, only model 1 (p<.06) and model 2 (p<.05) were (marginally) significant, whereas in girls none of the four models significantly added to the explanation of External eating (all p-values >.05).

Figures

Figure 1. The interaction effect between SP and interference control on restrained eating in girls.

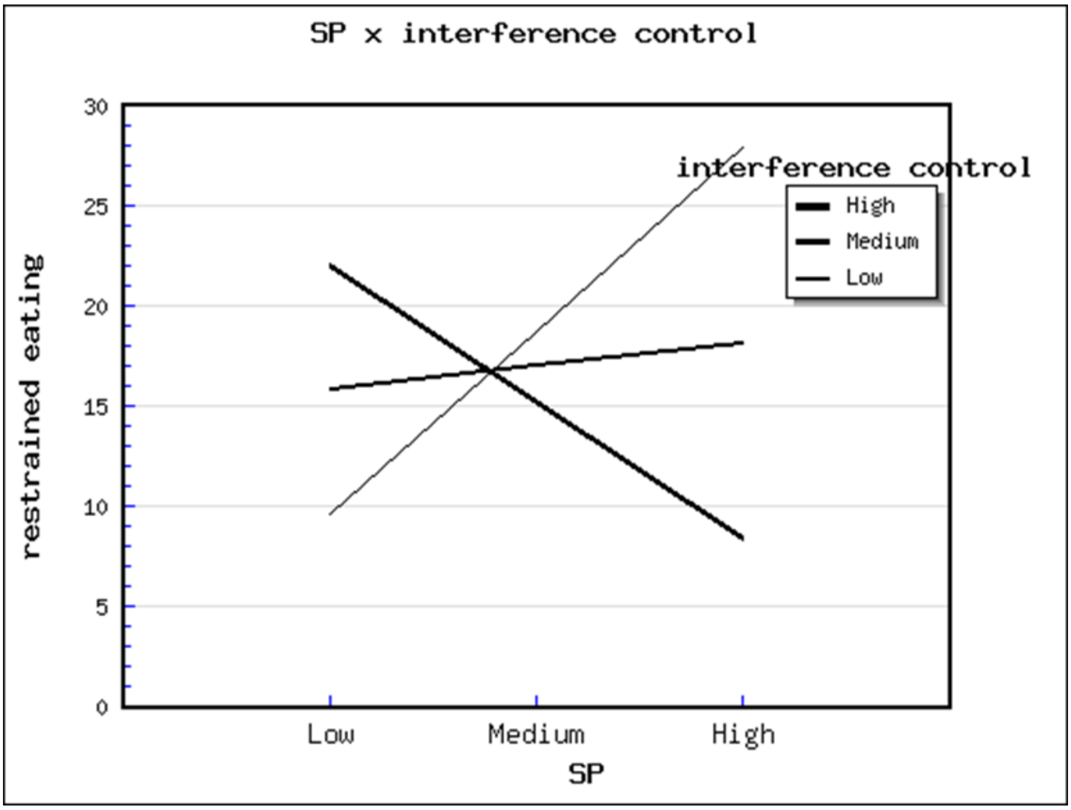


Figure 2. The interaction effect between SR and interference control on restrained eating in girls.

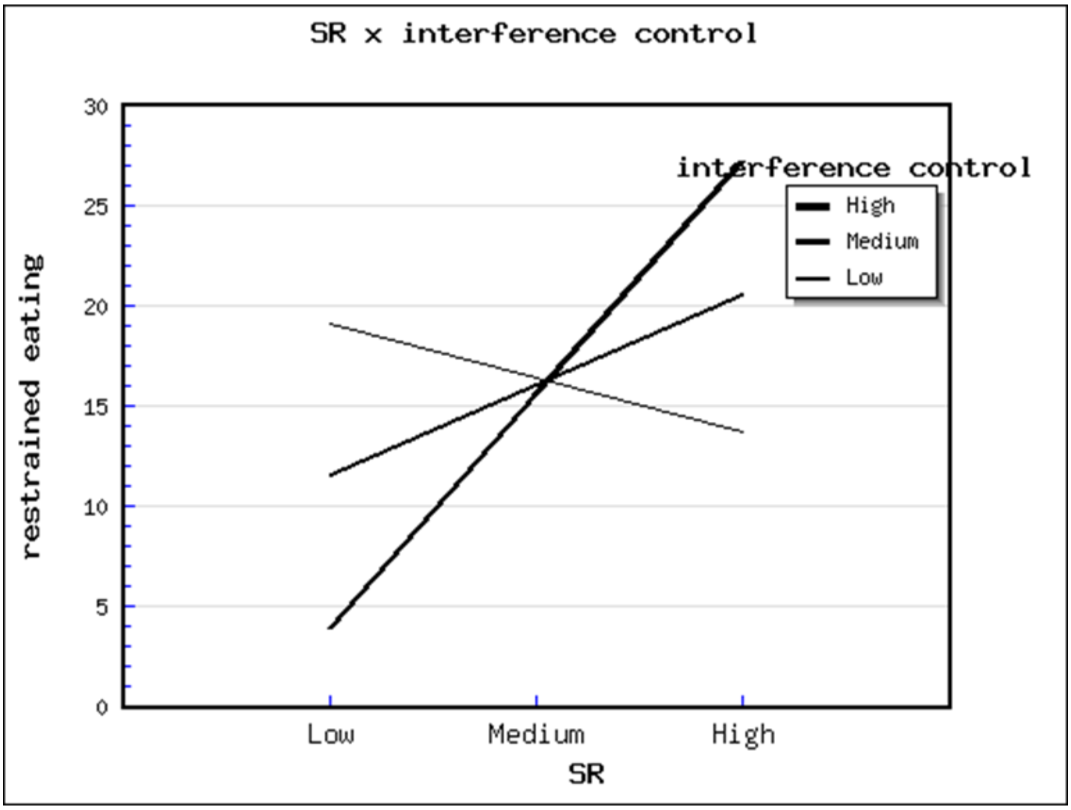
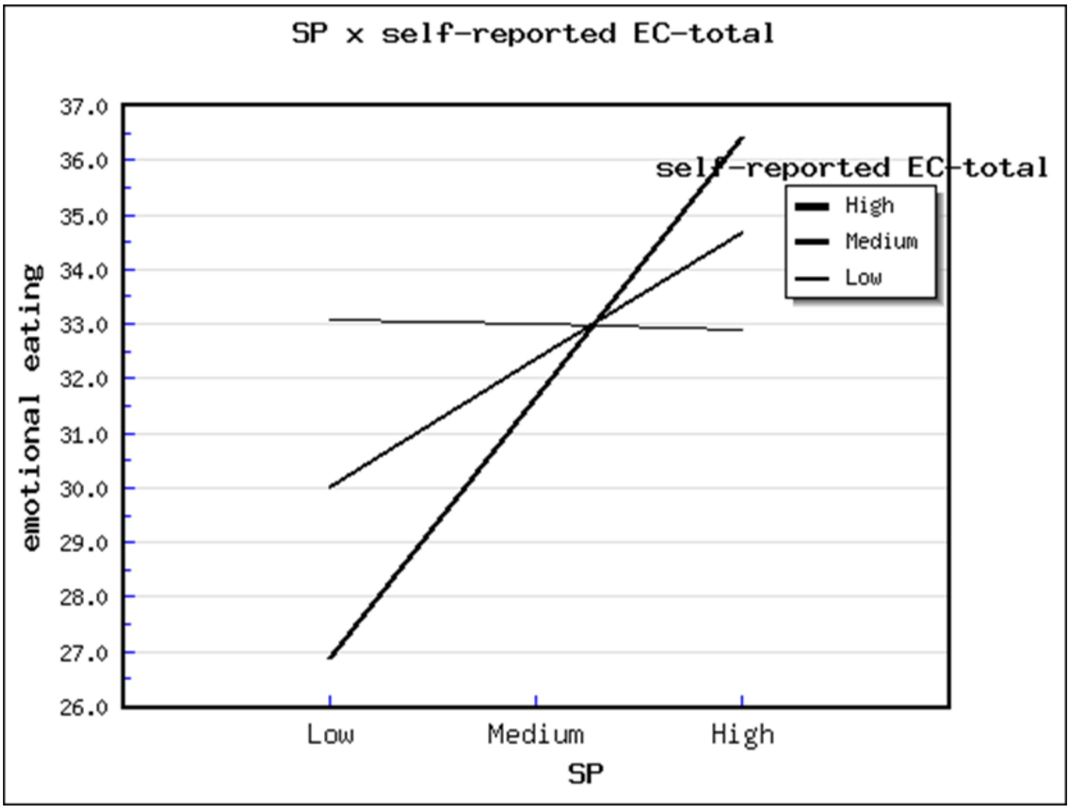


Figure 3.The interaction effect between SP and self-reported EC-total on emotional eating in girls.



Chapter 7: Discussion and conclusions

In the following chapter, the main goals of the present dissertation are recapitulated and the key findings of the different studies are integrated. The implications for future research as well as for clinical practice are discussed. Finally, the most important strengths and limitations of the present dissertation are highlighted.

Study Objectives

The goal of this dissertation was to gain more insight into the role of the temperament traits Sensitivity to Punishment (SP) and Sensitivity to Reward (SR), stemming from the Reinforcement Sensitivity Theory (Gray, 1970, 1982, 1987; Gray & McNaughton, 2000), in eating disorders. Based on several vulnerability models of psychopathology (Hankin & Abela, 2005; Lonigan, Vasey, Phillips, & Hazen, 2004; Munro, Randell, & Lawrie, 2016; Nigg, 2006; Nigg, Silk, Stavro, & Miller, 2005), it was assumed that SP and SR may be important variables to consider in research concerning eating disorders. The general underlying hypotheses in the present dissertation departed from the assumption that certain temperamental factors, such as SP and SR, may increase the risk of developing an eating disorder and may influence the course and outcome of eating disorders respectively. Several limitations in previous research regarding this topic gave rise to four main objectives within the present dissertation:

(1) to gain more insight into the level of SP and SR in patients with an eating disorder based on different self-report questionnaires and on a performance based task,

(2) to look for arguments regarding the assumed role of SP and SR as risk factors for the development of eating disorders,

(3) to look for arguments regarding the assumed maintaining role of SP and SR in eating disorders, and

(4) to gain more insight into the interactions between SP, SR and other traits in explaining disordered eating behaviour. In the following paragraphs, the findings regarding these four objectives will be discussed.

Present Results

Do Patients with an Eating Disorder show Similar Transdiagnostic and Interdiagnostic Differences in SP and SR Based on Different Instruments?

A first attempt to answer the previously described questions was made by examining trans-and interdiagnostic differences in the level of SP and SR in patients with an eating disorder and non-symptomatic controls. In the first study, SP and SR were measured by three different self-report questionnaires, whereas in the second study, SP and SR were measured with a spatial orientation task.

Study 1. Based on the results of study 1, patients with an eating disorder, regardless of the specific subtype and regardless of the specific questionnaire, appeared to be more sensitive for punishment compared to healthy controls. Moreover, AN-R patients scored significantly lower on SR compared to BN patients, regardless of the questionnaire being used. However, the results on the level of SR in non-symptomatic controls and patients with AN-B/P were different depending on the questionnaire being used. In other words, it was unclear where non-symptomatic controls and patients with AN-B/P were situated regarding SR in comparison with patients with AN-R or BN.

Study 2. The results on SP of study 2 were in line with the results of study 1. More specifically, patients with an eating disorder, regardless of the specific subtype, had a stronger attentional bias towards signals of punishment compared to non-symptomatic controls. However, in addition, a stronger difficulty to disengage their attention away from signals of punishment was found in patients with AN-B/P and BN compared to patients with AN-R, which indicated higher SP in patients with a binge/purge eating disorder compared to patients with AN-R. This interdiagnostic difference in SP on top of the transdiagnostic increase in SP was not found with the self-report questionnaires of study 1, which could imply that this is an implicit process.

Regarding SR, the findings of study 2 were opposite to the findings of study 1. More specifically, evidence was found for higher SR in patients with AN-R compared to patients with AN-B/P or BN based on the long delay reward disengagement trials.

Conclusions. Taken together, it can be concluded that SP was *transdiagnostically* increased in patients with an eating disorder. This result was consistently found based on different self-report questionnaires and a spatial orientation task and was in line with previous studies (e.g. Harrison, O'Brien, Lopez, & Treasure, 2010). Regarding the *interdiagnostic differences* on SP and SR, it is more difficult to draw clear conclusions based on the present results. When using self-report questionnaires, no interdiagnostic differences in SP were found and lower SR was found in patients with AN-R compared to patients with BN. However, when measuring attentional biases to signals of punishment or reward, the results were different with indications of higher SP in patients with a binge/purge eating disorder and higher SR in patients with AN-R. These results may confirm the hypothesis of study 2 that *self-report questionnaires versus behavioural tasks measure different aspects of SP and SR.* It seems important to differentiate between sensitivity for detecting cues of reward (and punishment), as was measured by the spatial orientation task, versus the experienced affect in rewarding (or punishing) situations that was assessed by the self-report questionnaires. If self-report questionnaires and performance based measures tap other aspects of SP and SR, more research including both self-reports and performance based measures seems necessary. In addition, it is necessary to further examine whether patients with an eating disorder are capable to objectively assess the level of these traits themselves. For example, patients with BN often consider themselves as 'failed anorectics' (Fairburn, Cooper, & Shafran, 2003) as they experience loss of control. It is possible that patients with BN judge themselves more reward sensitive than patients with AN departing from this perspective. More research including multi-informants could also be relevant in this regard. However, it should be kept in mind that in study 2, the subsamples were very small and patients with AN-B/P and BN were included as one subsample whereas they were examined separate from each other in study 1. This might have biased the results.

The results on SP were more consistent compared to the results on SR, which reflects the existing literature on this topic (e.g. Harrison et al., 2010; Jappe et al., 2011). This could be explained by the finding that, at presence, *the way SR is defined and operationalized is also more heterogeneous compared to SP* (e.g. Beck, Smits, Claes, Vandereycken, & Bijttebier, 2009). This might lead to different results, depending on how SR is operationalized. According to Dawe and Loxton (2004), it is important to differentiate between SR on the one hand and rash-spontaneous impulsiveness on the other. It is possible, for example, that especially rash impulsiveness, rather than SR an sich is specifically involved in impulsive binge eating and purging behaviour. According to Dawe and Loxton (2004), SR would be associated with greater sensitivity for food-related cues and food craving, whereas rash impulsivity is assumed to be associated with the component of loss of control during a binge eating episode and the inability to resist binge cravings.

Since defining SR has led to more difficulties compared to the concept of SP (e.g. Beck et al., 2009), more neurobiological studies may be necessary to gain a clearer definition of SR and to develop more adequate instruments to measure this concept.

Can we Find Arguments for the Hypothesis that SP and SR may Function as Risk Factors?

The general hypothesis regarding the role of SP and SR in eating disorders is that these traits may function as risk factors, increasing an individuals' vulnerability to develop an eating disorder (e.g. Harrison et al., 2010). If this is indeed the case, altered levels of SP and SR should be associated with disordered eating behaviour in non-clinical groups at risk, such as adolescents. Therefore, in study 3, an adolescent community sample was recruited to examine the association between specific SP/SR profiles and disordered eating behaviour.

Study 3. Four clusters or SP/SR profiles were found, described as low SP x low SR, high SP x high SR, high SP x low SR and low SP x high SR. Gender differences were found with more girls belonging to the high SP x low SR cluster (36.8% of the girls versus 21.3% of the boys) and more boys belonging to the low SP x high SR cluster (32.0% of the boys versus 15.3% of the girls. Moreover, eating styles and eating disorder symptoms, but not ABMI, were significantly associated with the clusters. Emotional eating, restraint, concerns about eating, body shape and weight were highest in the high SP x high SR cluster and the high SP x low SR cluster. Only external eating was highest in both clusters characterized by high SR.

Conclusions. Although the cross-sectional nature of the present study did not allow testing the hypothesis that SP and SR increase the vulnerability to develop an eating disorder, the present findings were in favour of this assumption. Clusters characterized by high SP seemed to be the most vulnerable clusters, in line with the transdiagnostically increased SP found in study 1 and study 2. The role of SR seemed to be most clear for external eating, which was highest in both clusters with high SR. This is in line with the finding of higher SR in patients with BN, found in study 1. All other eating styles and eating disorder symptoms were highest in the high SP x high SR cluster, which could imply that *high scores on both traits in particular created a vulnerable temperament profile*. However, the difference with the high SP x low SR cluster was often not significant, which could imply that especially the level of SP was important. These findings are consistent with previous research in non-clinical samples, showing that disordered eating behaviour is associated with heightened SP and SR (Loxton & Dawe, 2001, 2006). The finding that more girls belong to the most vulnerable cluster was also consistent with findings on the higher prevalence of eating disorders in girls (Hoek & Van Hoeken, 2013; Smink, van Hoeken, Oldehinkel, & Hoek, 2014).

Can we Find Arguments for a Maintaining Role of SP and SR in Eating Disorders?

The predominantly cross-sectional research comparing levels of SP and SR between diagnostic categories was expanded in the present dissertation by conducting a clinical follow-up study to examine the possible maintaining role of SP and SR in eating disorders. Moreover, not only the main effects of these traits, but also their interaction with each other and with the trait Persistence was examined.

Study 4. First, regarding symptom change, it should be noted that no significant decrease in drive for thinness and body dissatisfaction were found over the six month period. However, restrained eating and bulimic symptoms significantly decreased. Further, in the subsample of patients with AN-R and AN-B/P, BMI significantly increased. SP and SR were not predictive for these changes when using the SPSRQ (Torrubia, Avila, Molto & Caseras, 2001), except for the BMI increase. For this outcome variable, *a positive predictive effect of SP* was found, indicating that patients with the highest levels of SP gained more weight over the six month period. Interesting, when using the TCI (Cloninger, Svrakic, & Przybeck, 1993) several significant interaction effects were found. First, Harm Avoidance (HA) and Novelty Seeking (NS) interacted with each other in predicting decreased restrained eating. More specifically, relatively low HA combined with relatively high NS was *transdiagnostically associated with a decrease in restrained eating.* On top of that, a positive three way interaction effect of HA, NS and Persistence was found on both body dissatisfaction and bulimic symptoms, *indicating that high scores on all three traits were prognostically least favourable.*

Conclusions. These results suggested that SP, or at least the proxy measure HA, might form a maintaining factor in eating disorder symptoms, although this might only be the case in the presence of other moderating temperament traits and only for some specific ED symptoms. In general, heightened HA, in interaction with other traits, was predictive for short-term symptom increase in treatment seeking patients with an eating disorder, as expected. This was in line with the cross-sectional findings of study 1 and study 2 of heightened SP in patients with an eating disorder and further supports the hypothesis that *higher levels of SP may be involved in the development and/or course of an eating disorder* (e.g. Harrison et al., 2010). The only exception was found for BMI. For this outcome measure, the higher the level of SP, but not of HA, the more BMI increase was observed in patients with AN-R and AN-B/P. This positive predictive effect of SP was not found in previous research with BMI as an outcome variable (Glashouwer, Bloot, Veenstra, Franken, & De Jong, 2014) and needs further clarification. As mentioned in the discussion of study 4, a possible explanation lies in the finding that the level of SP may be positively associated with the severity of the illness (Glashouwer et al., 2014). Possibly, these patients could have been more motivated to gain weight or the therapists might have focused more strongly on weight gain.

The results also suggested that the influence of SR, or at least of the proxy measure NS, in eating disorder symptoms was dependent of other variables and was symptom specific. More specifically, relatively low NS, in interaction with relatively high HA, was associated with increases in restrained eating whereas high NS, in interaction with high HA and high Persistence was associated with increases in body dissatisfaction and bulimic symptoms. *This is in line with the idea that low SR is associated with restrictive eating disorders and high SR is associated with eating disorders that are partly characterized by binge eating* (e.g. Harrison et al., 2010). Regarding these findings, it should explicitly be noted that "high" NS and "low" HA refers to relative levels. Patients with an eating disorder show for example transdiagnostic high levels of HA, however, some of them will score even more extreme than others and those with relative lower levels of HA seem to improve more in terms of restrained eating. However, these results were instrument-specific as they were only found with the TCI and not with the SPSRQ.

It should be noted that the present results are hard to integrate in previous longitudinal research. Most clinical follow-up studies including measures of temperament as predictors of recovery, did not examine interactions and mostly included a longer time span (e.g. Bloks, Hoek, Callewaert, & Van Furth, 2004; Rowe, Jordan, McIntosh, Carter, Frampton, Bulik, & Joyce, 2011; Segura-Garcia, Chiodo, Sinopoli, & de Fazio, 2013). To our best knowledge, the only exception is the study of Glashouwer et al. (2014), examining the predictive interaction effect of SP and SR on symptom improvement. All these studies found little evidence for temperament as a predictor of recovery (Rowe et al., 2011; Segura-Garcia et al., 2013), but rather as a vulnerability factor for the development of an eating disorder (Bloks et al., 2004) and seemed to suggest that character traits, such as self-directedness, rather than temperament traits predict recovery (Bloks et al., 2004; Rowe et al., 2011)[6]. Interestingly, the present results on the other hand suggest that the interaction between certain temperament traits may be involved in the short-term evolution in specific eating disorder symptoms. It should be kept in mind that the small sample size might have influenced the results so replication is warranted. Nevertheless, the results of the present study seem to indicate that SP and SR do play a maintaining role in eating disorders, but only in interaction with each other and/or with other traits such as Persistence.

Do we Have to Acknowledge Other Temperament Factors?

Based on the joint subsystem hypothesis (Corr, 2002) and vulnerability theories of psychopathology (Hankin & Abela, 2005; Lonigan, et al., 2004; Munro, et al., 2016; Nigg, 2006; Nigg, et al., 2005), it is especially the interaction between different traits that should be taken into account when examining the association between temperament and mental disorders. This was done in the previously described study 4 as well as in study 5.

Study 4. Based on the previously described results of the clinical follow-up study, the trait Persistence seemed to interact with HA, as a proxy measure of SP, and with NS, as a proxy measure of SR, in predicting changes in body dissatisfaction and bulimic symptoms.

Study 5. The moderating role of the regulative character trait Effortful Control (EC) in the association between SP, SR and disordered eating behaviour in adolescents was examined in the final study of this dissertation. Both a self-report questionnaire of EC was included, as well as a performance based measurement of interference control. First, in both boys and girls, SP was positively correlated with restrained and emotional eating, whereas SR

[6] According to Cloninger et al. (1993), temperament traits are innate personality characteristics that manifest early in life whereas character traits refer to personality characteristics that mature in adulthood.

was positively correlated with emotional and external eating. In boys, there was no evidence for EC as a moderating variable. Only main effects of SP and SR were found. In girls on the other hand, there was some evidence that interference control might moderate the association between SP, SR and restrained eating. Moreover, EC, measured with a self-report questionnaire, seemed to moderate the association between SP and emotional eating in girls.

Conclusions. Based on the present results, it could be concluded that the association between SP, SR and disordered eating behaviour might be *moderated by other (regulative) temperament variables* such as Persistence and aspects of EC (R^2 change varied from .08 to .15). Several three way interactions were found in both studies between SP, SR and Persistence or EC. Although the present results were not decisive, this seems to suggest that other temperament traits may play a crucial role in the association between SP, SR and eating disorders and should be taken into account. This seems of particular importance with regard to the inconsistent findings on the association between SR and disordered eating behaviour (Glashouwer et al., 2014; Harisson et al., 2010; Jappe et al., 2011). More specifically, beside the previously discussed methodological issues regarding the operationalization of SR, the lack of including relevant moderators might also lead to inconsistent results.

It should be noted that the clinical sample of study 4 contained only female participants and in study 5, significant interaction effects were only found in adolescent girls. This could imply that the role of moderating traits in explaining disordered eating behaviour is different for girls versus boys.

General Conclusions Regarding the Role of SP and SR

In general, it was consistently found throughout the different studies that SP was positively associated with eating disorder symptomatology. In line with the existing research on SR, the role of SR in eating disorders remained less clear.

Sensitivity to Punishment. *The results regarding SP were in line with the hypothesis* that increased levels of SP are associated with eating disorder symptoms, may increase the vulnerability for an eating disorder and may be involved in the maintenance of certain eating disorder symptoms. However, the influence of SP was partly dependent of the influence of moderating traits. Moreover, it should be noted that, some results were (partly) in contradiction with these conclusions, such as the finding that high SP seemed to predict more short-term BMI increase in patients with underweight and the finding that especially HA as a proxy measure of SP and not SP itself was involved in symptom evolution. Moreover, although evidence was found that moderating variables, such as SR/NS, Persistence and EC may be involved in the association between SP and disordered eating behaviour, the exact role of these moderators was not clear yet and was beyond the scope of the present dissertation.

Sensitivity to Reward. *Regarding SR, it seemed that this trait might also play a role in eating disorders and eating disorder symptoms.* However, the way SR was defined and measured seemed to lead to different findings. There was some evidence that high SR might be associated with more approach behaviour towards food. For example, higher SR in BN compared to AN-R patients was found based on self-report questionnaires. In addition, it was found that adolescents with high SR reported more external eating. In the follow-up study, the two-way and three-way interactions involving NS (with low NS implied in increased restrained eating and high NS implied in increased bulimic symptoms) were also in line with this hypothesis. However, at the same time there was tentative evidence for higher SR in patients with AN-R compared to patients with AN-B/P and BN, if SR was operationalized as the sensitivity for detecting cues of reward. Moreover, it was found that SR was also related to eating disorder symptoms in different ways depending on the level of other moderating traits and depending on the sample characteristics. For example, whereas patients with AN-R scored lower on SR than patients with BN based on the self-report questionnaires and whereas relatively high NS, as a proxy of SR, combined with relatively low HA predicted decreases in restrained eating in a clinical sample, it seemed that SR was also positively associated with restrained eating in adolescent girls in the case of high EC. Taken together, these results seemed to be consistent with the hypothesis that SR might have a role as risk and maintaining factor in eating disorders, however, the nature of this role seemed to depend on the specific aspects of SR that were being measured, the specific eating disorder symptoms under examination, the clinical nature of the sample and the presence of moderating traits.

Explanations for the Association between SP, SR and Disordered Eating Behaviour. The association between SP, SR and eating disorders or eating disorder symptoms might be understood from *the theoretical proposition* that (1) high SP (i.e. sensitive BIS/FFFS) leads to *food avoidance*, hence restrained eating and AN-R, AN-B/P and BN, and that (2) high SR (i.e. sensitive BAS) leads to *food approach*, hence binge eating and AN-B/P and BN. In line with this, high SP in general has been found to be associated with more avoidant behaviour towards specific food stimuli also in younger children, whereas high SR in general has been found to be associated with more approach behaviour towards specific food stimuli in children (Vandeweghe, Vervoort, Verbeken, Moens, & Braet, 2016).

Several results from the present studies could indeed be explained from this perspective, for example the general finding that high SP was associated with disordered eating behaviour and several findings consistent with the idea that SR was associated with bulimic symptoms. However, it should also be noted that, although a connection at a primary level between SP and food avoidance is plausible, this does not seem to explain how high SP might be translated into the specific avoidance of food, since food is generally seen as a rewarding and not as a punishing stimulus. Moreover, high SP is not only found in relation to restrained eating, but also in relation to emotional eating and bulimic symptoms. A similar reasoning applies to SR: although several results suggested that SR was indeed related to bulimic symptoms, clinical practice shows that patients with binge eating symptoms do not always experience food as rewarding. Moreover, although this was a pilot study conducted in a small sample, the results on the spatial orientation task showed some evidence for a higher SR in AN-R patients compared to AN-B/P and BN patients. In addition, in the adolescent community sample, a positive main effect of SR on restrained eating was found in boys. This implies that SR does not solely influence eating behaviour on a primary level, leading to binge eating and purging behaviour, but that the association between this trait and eating disorder symptoms is more complex.

Taken together, it seems unlikely that the way SP and SR are involved in eating disorder symptoms is fully explainable from hunger- and satiety mechanisms and the attractiveness of food. 'Food' and 'eating' have probably gained other meanings through learning processes in patients with an eating disorder. More research is necessary to gain more insight into the complex nature of the association between SP, SR and disordered eating behaviour. Below, several guidelines for future research will be elaborated upon.

Future Research

Methodological issues

A first issue that may guide future research concerns the operationalization of SP and SR. It seems that more research is needed to get a better insight into the functioning of the BAS in humans and to define the concepts of impulsivity, novelty seeking and SR clearer. In addition, most research uses self-report questionnaires to measure SP and SR, both in this dissertation and in general. However, it is possible that individuals are not fully capable to report on these traits themselves, especially if, in clinical samples, punishment and reward are indeed contaminated (e.g. Keating, 2010). Moreover, self-report measures may not be suited to measure certain aspects of SP and SR, such as attentional biases. As such, it might be of particular importance to develop and use more performance based measures and neurological measures and to include multi-informant measures. The use of the spatial orientation task in this dissertation might be a step in that direction, but this pilot study needs replication. Regarding neurological studies, it might be important to conduct longitudinal studies to examine alterations in punishing and reward processing before, during and after the disorder.

Longitudinal and Non-Clinical Research

To gain more insight into the role of SP and SR as (causal) risk and maintaining factors for eating disorders, *longitudinal cohort studies* seem to be necessary. More research in non-clinical samples and comparisons between *clinical and non-clinical samples* might also shed more light on how SP and SR could function as risk factors. For example, although more research on this topic is necessary as well, SP might increase and SR might decrease as a consequence of the eating disorder (Bloks et al., 2004). This means that SP and SR may be differentially associated with the development versus the maintenance of an eating disorder. In clinical samples, research regarding the predictive value of SP and SR in transdiagnostic cross-overs may be conducted as well. More specifically, patients with an eating disorder often migrate across different eating disorder subtypes over time (Castellini, lo Sauro, Mannucci, & Ravaldi, 2011). Based on the hypothesis that SP and

SR may play a maintaining role in eating disorders, it seems not unlikely that they may be involved in these cross-overs as well.

Evaluating the role of Mediating and Moderating Variables

Sensitivity for Social Rejection as a Mediator. Patients with an eating disorder have been found to be more sensitive for punishments and less sensitive for rewards in the social context compared to healthy controls. More specifically, patients with AN or BN have been found to show an attentional bias towards rejecting faces and an attentional avoidance of accepting faces, while the opposite is found in healthy controls (Cardi, De Matteo, Corfield, & Treasure, 2013). AN-R patients have also been found to show an avoidant reaction in response to social reward and an approach reaction towards social punishment (Via et al., 2015). These findings suggest that high SP and/or low SR may increase the risk to develop an eating disorder by the way social situations are perceived. More specifically, this high SP and low SR in social situations might contribute to the lack of control that is often experienced by patients with an eating disorder in social situations (Sternheim, Konstantellou, Startup, & Schmidt, 2010). Their eating disorder might in part be a way to compensate that lack of control by (an attempt to) control their eating behaviour (Frank, 2013; Zucker, Losh, Bulik, LaBar, Piven, & Pelphrey, 2007).

From this perspective, both high SP and low SR could enhance the risk for an eating disorder via social punishment/reward processing. This means that based on this possible pathway, high SR might be protective in general, whereas based on the primary biological pathway, low SR might be protective, specifically for bulimic symptoms. As such, it might be relevant in future research to examine sensitivity for social rejection as a mediator in the association between SP, SR and disordered eating behaviour.

Emotion Regulation Difficulties as a Mediator. A second mediational pathway that might be important to examine in the future is a pathway via emotion regulation problems. More specifically, SP as well as some aspects of SR are positively associated with difficulties with emotion regulation (Tull, Gratz, Latzman, Kimbrel, & Lejuez, 2010). More specifically, Tull et al. (2010) found the BAS-subscale Fun Seeking to be positively associated with emotion regulation difficulties, whereas the BAS-subscale Reward Responsiveness was negatively associated with emotion regulation difficulties. Problems with emotion regulation in turn could increase the risk to develop an eating disorder, since for example binge eating appears to be a way of coping with difficult emotions (e.g. Tapper, Baker, Jiga-Boy, Haddock, & Maio, 2015).

If this hypothesis would be confirmed in the future, this would have several implications. First, this mediational pathway could explain how both high SP and high SR can be involved in both restrained eating and binge/purge symptoms, since both behaviours are regarded as emotion regulation strategies (Macht, 2008). More specifically, emotions are related to eating behaviour in various ways, such as emotional suppression of food intake versus eating to regulate emotions (Macht, 2008).

Secondly, it should be noted that the finding that only some aspects of SR are positively related to emotion regulation difficulties, while other aspects are negatively related to emotion regulation difficulties (Tull et al., 2010), might explain the inconsistent results regarding the association between SR and eating disorder symptoms depending on how SR is operationalized.

Moderating Variables. In addition to the possible role of mediators, study 4 and study 5 showed some evidence that the influence of SP and SR might be partly dependent on the presence of moderating variables, such as Persistence and EC. Like EC, emotion related self-regulation strategies may also play a moderating role in the relation between SP, SR and eating disorder symptoms, as well as for example stressful life events. It seems important to conduct more research on moderating variables in the association between SP, SR and disordered eating behaviour. This might increase our understanding of how SP and SR are involved in disordered eating behaviour as well as our insight into the circumstances under which certain SP/SR profiles may either lead to an eating disorder versus to other types of psychopathology such as, for example, major depression (Must, Szabó, Bódi, Szász, Janka, & Kéri, 2006).

Altered Punishment and Reward Processing

An additional hypothesis requiring further research, is that not only the level of SP and SR might be altered in patients with eating disorders, but also the nature of the stimuli that are experienced as punishing or rewarding. According to the contamination reward theory (Keating, 2010; Keating, Tilbrook, Rossell, Enticott & Fitzgerald, 2012; Södersten, Nergardh, Bergh, Zandian, & Scheurink, 2008) some primary positive stimuli become punishing and some primary negative stimuli become rewarding in patients with AN. Although this has mostly been examined in patients with AN, it seems that at least in this specific subgroup, the pathological behaviour becomes rewarding instead of punishing in the first instance. For example, early studies show that starvation is experienced as rewarding in patients with AN (Bergh & Södersten, 1996). Moreover, there is a neural overlap between reward processing and punishment processing circuits, which might lead to contamination between aspects of punishment versus reward by patients with an eating disorder (Keating, 2010). This could add to the inconsistent results regarding SR in the sense that patients with an eating disorder are perhaps not more or less sensitive for reward, but they might experience reward differently. This further supports the need for more research using performance based and neurological measures. In addition, examining sensitivity to *different types of punishment and reward,* such as food related reward/punishment and social reward/punishment, seems relevant from this perspective. This seems of particular importance based on for example the finding that items related to social reward correlated positively with restrained eating in study 5, while this was not found for the other items measuring SR.

Clinical Implications

The five different studies of the present dissertation supported the hypothesis that SP and SR are involved in disordered eating behaviour. Although it cannot be denied that it might be difficult to modify temperament traits through therapeutic interventions, getting insight in the disorder and learning strategies to cope with temperamental vulnerabilities may increase the impact of therapy on temperament. In line with this, some important aspects of the association between SP, SR and eating behaviour may become therapeutic targets in the future, based on the present results.

First, the tentative finding of higher attentional bias towards cues predicting punishment in patients with an eating disorder compared to non-symptomatic controls, might suggest that *training of attentional processes* could be useful. Since this was a small pilot study, more research regarding this topic will be necessary first. However, it has already been found that attentional bias towards signals of social rejection might be reduced by a bias reduction training (Dandeneau & Baldwin, 2004). If more insight is gathered into the attentional biases that may result from high SP, developing training programs aimed at modifying these biases may be efficient.

Second, there was also some evidence that, at least in adolescent girls, SP and SR may interact with EC. Because EC is assumed to have a high level of plasiticity (Berkman, Graham, & Fisher, 2012), *training programs aimed* *at* enhancing or decreasing certain aspects of *EC* may be efficient. However, before this is possible, a better insight into which aspects of EC may function as protective factors and for which specific temperament profile they do so, is necessary first.

Beside possible implications for therapeutic interventions, the results of the present studies may also suggest that *temperament profiles*, and not scores on isolated traits, may be taken into account *for screening and prognostic purposes*. High scores on both SP and SR seemed to form the least favourable profile in general. However, replication of the present results regarding which SP/SR clusters show the highest prevalence of disordered eating behaviour is necessary as well as more clinical follow-up studies.

Finally, throughout the different studies, evidence of a positive association between SP and disordered eating behaviour was found. This might have important implications regarding the *therapeutic attitude* towards patients with an eating disorder. More specifically, if the BIS/FFFS of patients with an eating disorder is hyperresponsive, therapists might have to pay particular attention to the avoidance of fear inducing interpersonal situations and criticism during the sessions because patients may experience more difficulties to learn new cognitions/behaviour in an anxious state. This might form a big challenge for the therapist, given the powerlessness that is often experienced by therapists due to the rigidity of patients with an eating disorder and because feedback is mostly experienced as critique by patients.

Strengths and Limitations

Strengths

The present studies tried to meet some of the shortcomings in the literature so far on the role of SP and SR in eating disorders and eating disorder symptoms. Regarding the designs and methodological aspects of the different studies, it could be considered a strength that both clinical samples and non-clinical samples were included. The non-clinical samples also consisted of both male and female participants, which allowed taking possible gender effects into account. This is important since many studies focus mainly on girls (e.g. Walther & Hildebert, 2016). Moreover, although four out of the five studies used self-report questionnaires to operationalize SP and SR, a performance based measure was also included in study 2. In addition, it should be noted that three of the other studies used more than one self-report questionnaire to measure SP and SR, which helped to get a better insight into instrument-specific findings. In several studies, interaction effects between different temperament traits were also examined, which has rarely been done before and which might help to understand how SP and SR are related to eating disorder symptomatology. Throughout the different studies, several statistical techniques and designs were used as well.

By doing so, the present results expand our knowledge on the role of SP and SR in eating disorder symptomatology. Moreover, some important clinical implications follow from the present results, which were previously discussed. However, several limitations should also be noted. These will be discussed next.

Limitations

A first limitation of the present dissertation is that the clinical samples of study 1 and study 4 were partially overlapping and that the sample sizes of especially study 2 and study 4 were limited whereas complex analyses were performed on these samples. This limitation also applies to the adolescent subsample of study 5 that completed the Colour-Word Stroop Task (Stroop, 1935). These small and sometimes partly overlapping samples might have biased the results, implying, as previously mentioned, that replication with larger clinical samples is necessary. However, despite the small sample sizes, different significant effects of SP and SR were found, which supports the assumed importance of these traits in eating disorder symptomatology.

A second limitation is the absence of patients with Binge Eating Disorder (BED) in study 1 and study 2. To expand our knowledge on the role of SP and SR in different eating disorder subtypes, it will be necessary to include this diagnostic subcategory as well. Since study 1 and study 2 adopted a categorical approach towards the eating disorder subtypes and had the main goal of replicating previous results with different instruments, it was chosen not to include BED. However, in study 4, which departed from a more dimensional perspective on different eating disorder subtypes, patients with BED were included.

A third limitation is the lack of a non-clinical follow-up study and of multiple follow-up moments in study 4. This was outside the scope of the present dissertation, given the different practical obstacles such as sufficient time to conduct such a design. Without more longitudinal and experimental research in both clinical and non-clinical samples, it remains impossible to draw conclusions on the causal role of SP and SR in eating disorder symptomatology. However, in study 4 a step in this direction was taken by conducting a short-term follow-up design.

A final limitation of not only the studies in the present dissertation, but of most studies on SP and SR, is the lack of valid instruments based on the revised reinforcement sensitivity theory (Gray & McNaughton, 2000) to measure SP and SR. More methodological research is necessary in this regard.

Summary

The present dissertation attempted to (1) to gain more insight into the level of SP and SR in patients with an eating disorder based on different self-report questionnaires and on a performance based task,

(2) to look for arguments regarding the assumed role of SP and SR as risk factors for the development of eating disorders,

(3) to look for arguments regarding the assumed maintaining role of SP and SR in eating disorders, and

(4) to gain more insight into the interactions between SP, SR and other traits in explaining disordered eating behaviour.

Based on the results, we can say that further evidence was indeed found for the hypothesis that SP and SR are involved in eating disorder symptomatology. SP seemed to be positively correlated with eating disorder symptoms, both in patients with an eating disorder and in non-clinical adolescents. This was not only found with self-report questionnaires, but also with a spatial orientation task showing increased attentional bias to punishment in patients with an eating disorder. SR was particularly related to bulimic symptoms, although the evidence on this topic was not consistent. For example, patients with AN-R had a stronger attentional bias to reward compared to patients with AN-B/P or BN. Some tentative evidence was also found in line with the hypothesis that SP and SR may function both as vulnerability and as maintaining factors for eating disorders. Moreover, other traits, such as Persistence and EC may moderate the association between SP, SR and disordered eating behaviour.

However, several unanswered questions and inconsistent findings remain, along with some methodological issues regarding the operationalization of SP and SR. Taking together the existing evidence that SP and SR may play an important role in eating disorders, more research is still necessary to explain how SP and SR are involved in eating disorder symptomatology. The present studies may form one step on this road to more knowledge on the role of SP and SR in eating disorders.

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Nederlandse samenvatting

Dit doctoraatsproefschrift bestaat uit zeven hoofdstukken. Het eerste hoofdstuk geeft een algemene introductie tot eetstoornissen en tot de rol van de temperamentkenmerken straf- en beloningsgevoeligheid in eetstoornissen. Binnen dit hoofdstuk worden ook de centrale doelstellingen van het huidige proefschrift omschreven. In hoofdstuk twee tot en met zes worden vijf afzonderlijke empirische studies beschreven. Binnen deze studies wordt ten eerste getracht meer inzicht te krijgen in trans- en interdiagnostische verschillen in straf- en beloningsgevoeligheid tussen patiënten met verschillende types eetstoornissen en controlegroepen. Vervolgens wordt nagegaan of een verband tussen straf- en beloningsgevoeligheid en eetstoornissymptomen tevens kan gevonden worden in een risicogroep, zoals adolescenten uit de algemene populatie. Dit is gebaseerd op de hypothese dat straf- en beloningsgevoeligheid fungeren als risicofactoren voor eetstoornissen. Daarnaast wordt het verband tussen straf- en beloningsgevoeligheid en de evolutie in eetstoornissymptomen onderzocht, alsook de mogelijke modererende rol van andere temperamentkenmerken. In hoofdstuk 7 wordt tenslotte een overzicht gegeven van de belangrijkste bevindingen binnen dit proefschrift en worden deze geïntegreerd binnen de bestaande literatuur. De implicaties voor verder onderzoek en voor de klinische praktijk worden hierbinnen ook besproken.

Hoofdstuk 1: Inleiding

Wat Zijn Eetstoornissen?

Eetstoornissen zijn ernstige psychische stoornissen met een zeer negatieve impact op de levenskwaliteit en een hoog sterftecijfer (Carta et al., 2014). Ze ontstaan vaak in de adolescentie, vooral bij meisjes, en kunnen tot in de volwassenheid blijven voortbestaan (Kotler, Cohen, Davies, Pine, & Walsh, 2001).

Algemeen kan een eetstoornis gedefinieerd worden als *een persistente stoornis in het eetgedrag of in gedrag met gewichtscontrole als doel, dat de fysieke gezondheid en het psychosociaal functioneren belemmert* (Fairburn & Walsh, 2002, p.171). Op basis van de *Diagnostic and Statistical Manual of Mental Disorders* 5de editie (DSM-5; APA 2013), zijn de belangrijkste eetstoornissen die kunnen voorkomen bij adolescenten en volwassenen Anorexia Nervosa (AN), Bulimia Nervosa (BN) en de Eetbuistoornis (of *Binge Eating Disorder* (BED)).

AN wordt gekenmerkt door een restrictief eetpatroon, een intense angst om bij te komen in gewicht terwijl men in realiteit ondergewicht heeft, en een verstoord lichaamsbeeld. Er worden twee subtypes onderscheiden, zijnde AN van het restrictieve type (AN-R) en AN van het eetbui/purgerende type (of *binge/purge type* (AN-B/P)). Bij patiënten met AN-R is het ondergewicht een gevolg van een restrictief eetpatroon, zonder dat hierbij eetbuien of purgeergedrag voorkomen. Bij patiënten met AN-B/P wordt niet alleen een restrictief eetpatroon vastgesteld, maar vinden er tevens eetbuien en/of purgeergedrag plaats.

BN is een eetstoornis die gekenmerkt wordt door eetbuien (hiermee bedoelt men het eten van een objectief grote hoeveelheid voedsel binnen een korte tijdsperiode en de ervaring van controleverlies over deze voedselinname), herhaaldelijk compensatiegedrag om gewichtsstijging te voorkomen, zoals bijvoorbeeld zelfopgewekt braken, en een zelfevaluatie die grotendeels gebaseerd is op lichaamsvorm en gewicht.

Gelijkaardig aan BN, wordt ook BED gekenmerkt door herhaaldelijk eetbui-episodes. Het verschil met BN is echter dat patiënten met BED geen compensatiegedrag stellen voor deze eetbuien.

Temperament en Eetstoornissen

Straf- en Beloningsgevoeligheid. Verschillende ontwikkelingsmodellen van psychopathologie suggereren dat de interactie tussen verschillende factoren een rol speelt in het ontstaan van mentale stoornissen, zoals eetstoornissen. Zo wordt er binnen kwetsbaarheid-stress modellen aangenomen dat psychopathologie ontstaat door de interactie tussen een zekere kwetsbaarheid, bijvoorbeeld binnen het temperament van een individu, en externe stressoren (Hankin & Abela, 2005; Munro, Randell, & Lawrie, 2016). Andere modellen gaan ervan uit dat psychopathologie ontstaat door de interactie tussen reactieve persoonlijkheidskenmerken en regulerende persoonlijkheidskenmerken (Lonigan, Vasey, Phillips, & Hazen, 2004; Nigg, 2006; Nigg, Silk, Stavro, & Miller, 2005). Binnen het huidige proefschrift ligt de nadruk op de mogelijke rol die temperament kan spelen in de ontwikkeling van eetstoornissen, meer bepaald als een kwetsbaarheidsfactor die het risico op een eetstoornis kan verhogen en een eetstoornis mogelijks ook mee in stand kan houden. Meer specifiek wordt hierbij gefocust op de rol van straf- en beloningsgevoeligheid.

Straf- en beloningsgevoeligheid worden gedefinieerd als de gevoeligheid om signalen van respectievelijk straf en beloning op te merken en als de intensiteit van het respectievelijk negatieve en positieve affect dat ervaren wordt in straffende en belonende situaties (Davis & Fox, 2008). Deze temperamentkenmerken zijn afkomstig van de *Reinforcement Sensitivity Theory* (RST; (Gray, 1970, 1982, 1987; Gray & McNaughton, 2000). Deze theorie stelt dat er drie biologische systemen aan de basis liggen van motivationeel gedrag. Deze systemen zijn het Gedragsactivatiesysteem of *Behavioural Activation System* (BAS), het Gedragsinhibitiesysteem of *Behavioural Inhibition System* (BIS) en het Vecht-Vlucht-Bevries Systeem of *Fight-Flight-Freeze System* (FFFS). Gebaseerd op de meest recente herziening van de RST (Gray & McNaughton, 2000), staat het BAS in voor reacties op aantrekkelijke stimuli. Het FFFS is hierin de tegenhanger van het BAS in die zin dat dit systeem instaat voor reacties op aversieve stimuli. Het BIS wordt gezien als een systeem dat geactiveerd wordt wanneer er een conflict is tussen verschillende aantrekkelijke en/of aversieve stimuli en dat gedrag stil legt tot wanneer men een keuze heeft gemaakt. Beloningsgevoeligheid wordt binnen dit proefschrift gezien als een temperamentskenmerk dat samenhangt met de gevoeligheid van het BAS, terwijl strafgevoeligheid gezien wordt als een temperamentskenmerk dat samenhangt met de gevoeligheid van het BIS en het FFFS (Harrison, O'Brien, Lopez, & Treasure, 2010).

Empirische Bevindingen. De algemene veronderstelling is dat strafgevoeligheid gerelateerd is aan eetstoornissen omdat dit temperamentskenmerk samengaat met meer angst en inhibitie. Dit laatste kan onder meer gerelateerd worden aan restrictief eetgedrag. Beloningsgevoeligheid wordt verondersteld samen te hangen met eetstoornissen die gekenmerkt worden door eetbuien en purgeergedrag. Dit omwille van het verband tussen het BAS en impulsiviteit en omwille van de belonende waarde van voeding (Gray, 1970, 1982, 1987; Gray & McNaughton, 2000; Harisson et al., 2010).

Eerder onderzoek toonde reeds aan dat er inderdaad trans- en interdiagnostische verschillen kunnen gevonden worden in straf- en beloningsgevoeligheid tussen patiënten met verschillende types eetstoornissen en gezonde controlegroepen. Binnen deze cross-sectionele studies wordt meestal gevonden dat patiënten met een eetstoornis, ongeacht het type eetstoornis, hoger scoren op strafgevoeligheid in vergelijking met gezonde controlegroepen. Het niveau van beloningsgevoeligheid blijkt vaak verhoogd te zijn bij patiënten met BN en verlaagd bij patiënten met AN, hoewel de resultaten vaak tegenstrijdig zijn (Harrison, et al., 2010). Ook in niet-klinische groepen vond men meermaals positieve verbanden tussen straf- en beloningsgevoeligheid en eetstoornissymptomen (Loxton & Dawe, 2001, 2006; Walther & Hilbert, 2006).

Tekorten in de Huidige Literatuur. Er is dus reeds enige evidentie dat straf- en beloningsgevoeligheid een rol zouden kunnen spelen in het ontstaan en de instandhouding van eetstoornissen. Er zijn echter nog verschillende onduidelijkheden m.b.t. dit onderwerp. Zo wordt er gebruik gemaakt van veel verschillende vragenlijsten om straf- en beloningsgevoeligheid te meten en wordt er weinig onderzoek gedaan met gedragsmaten. Dit kan bijdragen tot de vaak inconsistente resultaten, vooral m.b.t. interdiagnostische verschillen in beloningsgevoeligheid. Bovendien wordt er in beperkte mate onderzoek gedaan naar het verband tussen deze trekken en verstoord eetgedrag in kwetsbare groepen, zoals adolescenten. Dit is echter belangrijk indien straf- en beloningsgevoeligheid inderdaad functioneren als kwetsbaarheidsfactoren. Daarnaast is er ook weinig longitudinaal onderzoek en worden zelden interacties tussen verschillende temperamentskenmerken in rekening genomen. Dit beperkt ons huidig inzicht in hoe straf- en beloningsgevoeligheid een rol kunnen spelen in eetstoornissen.

Doelstellingen binnen het Proefschrift

De hierboven besproken bevindingen en tekortkomingen in de huidige wetenschappelijke literatuur hebben geleid tot vier centrale doelstellingen binnen het huidige proefschrift.

Het eerste doel was om na te gaan of dezelfde trans- en interdiagnostische verschillen in straf- en beloningsgevoeligheid worden gevonden tussen participanten met en zonder een eetstoornis op basis van verschillende vragenlijsten en een gedragsmaat van straf- en beloningsgevoeligheid (zie hoofdstuk 2 en hoofdstuk 3).

Het tweede doel was om na te gaan of er evidentie kan gevonden worden voor de hypothese dat de trekken straf- en beloningsgevoeligheid kunnen functioneren als kwetsbaarheidsfactoren (zie hoofdstuk 4).

Het derde doel was om na te gaan of er evidentie kan gevonden worden voor de hypothese dat de trekken straf- en beloningsgevoeligheid kunnen functioneren als instandhoudende factoren binnen eetstoornissen (zie hoofdstuk 5).

Het vierde en laatste doel binnen het proefschrift was om na te gaan of andere temperamentfactoren mee moeten opgenomen worden als moderatoren om het verband tussen straf- en beloningsgevoeligheid en verstoord eetgedrag te kunnen begrijpen (zie hoofdstuk 5 en hoofdstuk 6).

Hoofdstuk 2: Temperamentsverschillen Tussen Adolescenten en Jongvolwassen Met en Zonder een Eetstoornis

Hoewel ervan wordt uitgegaan dat verschillende types eetstoornissen verschillende uitingen zijn van dezelfde onderliggende mechanismen (Fairburn, Cooper, & Shafran, 2003), blijft het onduidelijk waarom het restrictieve eetpatroon van patiënten met AN-R persisteert, terwijl patiënten met BN heen en weer lijken geslingerd te worden tussen eetbuien en restrictie. Een deel van de verklaring ligt mogelijks bij temperamentverschillen. Zoals beschreven in hoofdstuk 1, is er toenemend bewijs dat temperamentkenmerken, en in het bijzonder de kenmerken straf- en beloningsgevoeligheid, een rol spelen in eetstoornissen en mogelijks mee het type eetstoornis bepalen. Zoals eerder aangegeven, zijn de resultaten echter niet steeds consistent, vooral wat betreft het niveau van beloningsgevoeligheid in patiënten met AN (Harrison et al., 2010; Jappe et al., 2011). Eén van de verklaringen hiervoor is mogelijks het gebruik van verschillende vragenlijsten doorheen verschillende studies om hetzelfde concept te operationaliseren (Harrison et al., 2010). Daarom was het doel van studie 1 om verschillen in straf- en beloningsgevoeligheid na te gaan tussen patiënten met AN-R, AN-B/P, of BN en een controlegroep van individuen zonder eetstoornis, gebruik makend van verschillende vragenlijsten om straf- en beloningsgevoeligheid te meten.

Meer specifiek werden drie vragenlijsten geselecteerd die vaak gebruikt worden binnen dit onderzoeksdomein, zijnde de Strafgevoeligheid en Beloningsgevoeligheid Vragenlijst (*Sensitivity to Punishment and Sensitivity to Reward Questionnaire* (SPSRQ); Torrubia, Avila, Molto, & Caseras, 2001), de BIS/BAS Schalen (Carver & White, 1994) en de Temperament en Karakter Vragenlijst (*Temperament and Character Inventory* (TCI); Cloninger, Svrakic, & Przybeck, 1993). De eerste twee vragenlijsten zijn gebaseerd op de eerder beschreven RST (Gray, 1970, 1982, 1987; Gray & McNaughton, 2000). De TCI is gebaseerd op een gerelateerd persoonlijkheidsmodel, zijnde het persoonlijkheidsmodel van Cloninger (Cloninger et al., 1993). Dit model stelt vier temperamentkenmerken voorop, die een grote genetische/aangeboren component hebben, en drie karaktertrekken die ontstaan naarmate een individu zich ontwikkelt. De vier temperamentkenmerken betreffen de mate waarin iemand Leedvermijdendheid is (*Harm Avoidance* (HA)), Prikkelzoekend is (*Novelty Seeking* (NS)), Doorzettingsvermogen heeft (*Persistence* (P)) en Sociaal Gericht is *(Reward Dependency* (RD)). HA en NS vormen binnen dit model de twee belangrijkste trekken die gedragsinhibitie en gedragsactivatie aansturen. HA wordt meer bepaald gedefinieerd als de neiging om gedrag te inhiberen wanneer men geconfronteerd wordt met aversieve stimuli, terwijl NS gedefinieerd wordt als de neiging om actief te reageren op nieuwe stimuli. HA en NS worden dan ook gerelateerd aan respectievelijk straf- en beloningsgevoeligheid (Mardaga & Hansenne, 2007) en de TCI wordt bijgevolg vaak gebruikt om HA en NS te meten als indicatie voor straf- en beloningsgevoeligheid (Harrison et al., 2010).

Op basis van deze vragenlijsten, werd binnen de huidige studie evidentie gevonden voor verhoogde strafgevoeligheid bij patiënten met een eetstoornis in vergelijking met de controlegroep. Dit resultaat werd gevonden ongeacht de specifieke eetstoornisdiagnose en ongeacht de vragenlijst die gebruikt werd. Daarnaast werd ook gevonden dat patiënten met AN-R significant lager scoorden op beloningsgevoeligheid in vergelijking met patiënten met BN. Echter, de verschillen patiënten met AN-R en BN enerzijds en de patiënten met AN-B/P en de controlegroep anderzijds, verschilden afhankelijk van de vragenlijst die gebruikt werd.

Dit betekent dat, in lijn met eerdere bevindingen (Harrison et al., 2010; Jappe et al., 2011), de resultaten rond strafgevoeligheid eenduidiger waren dan de resultaten m.b.t. beloningsgevoeligheid. Zoals verwacht, lijken patiënten met een eetstoornis gekenmerkt te worden door verhoogde strafgevoeligheid en lijkt beloningsgevoeligheid hoger te zijn bij patiënten met een eetbui/purgerende problematiek in vergelijking met patiënten met een puur restrictieve eetstoornis.

Hoofdstuk 3: Gevoeligheid voor Voorspellers van Beloning en Straf bij Jonge Vrouwen met een Eetstoornis

In het voorgaande hoofdstuk werden de verschillen in straf- en beloningsgevoeligheid nagegaan tussen patiënten met een eetstoornis en een controlegroep met behulp van zelfrapportage. Het is echter belangrijk om op te merken dat straf- en beloningsgevoeligheid gedefinieerd worden als de gevoeligheid om signalen van straf/beloning te detecteren en als de intensiteit van het negatieve/positieve affect dat ervaren wordt in straffende/belonende situaties (Davis & Fox, 2008). Vragenlijsten richten zich vooral op dit laatste aspect, maar zijn minder geschikt om het eerste aspect in kaart te brengen. Om de gevoeligheid voor voorspellers van straf of beloning te meten, lijken gedragstaken meer aangewezen. Daarom werd binnen studie 2 gebruik gemaakt van een Ruimtelijke Oriëntatie Taak (*Spatial Orientation Task* (SOT); Derryberry & Reed, 1994) om straf- en beloningsgevoeligheid te vergelijken tussen patiënten met een restrictieve eetstoornis (AN-R), patiënten met een eetstoornis gekenmerkt door eetbuien en purgeergedrag (AN-B/P en BN) en een controlegroep met individuen zonder een eetstoornis.

Aan de hand van deze computertaak wordt de aandachtsbias van deelnemers gemeten binnen verschillende spelblokken. Binnen deze spelblokken verschijnt er steeds een blauw of een rood pijltje, dat fungeert als voorspeller voor respectievelijk beloning of straf. Nadien verschijnt er een vierkantje waarop participanten zo snel mogelijk moeten reageren door het indrukken van een toets. Indien voorafgegaan door een blauwe pijl, verschijnt het vierkantje doorgaans op de plaats van de pijl en heeft men verhoogde kans om tijdig te reageren (de toegelaten reactietijd is langer). Indien voorafgegaan door een rode pijl, verschijnt het vierkantje doorgaans op de plaats tegenover de pijl en heeft men verlaagde kans om tijdig te reageren (de toegelaten reactietijd is korter). Uitzonderlijk verschijnt het vierkantje ook op de niet-verwachte locatie. Op deze manier wordt zowel verhoogde aandacht voor signalen van straf/beloning gemeten, alsook de snelheid waarmee men de aandacht weg kan richten van verwachtte straf/beloning. Bovendien wordt de tijd tussen een signaal en het vierkantje gevarieerd, zodat men zowel meer automatische aandachtsprocessen kan meten, als meer gecontroleerde processen.

Op basis van deze gedragstaak, kwamen andere resultaten naar voor in vergelijking met de voorgaande studie. Zo werd geen verhoogde beloningsgevoeligheid waargenomen bij patiënten met AN-B/P of BN in vergelijking met patiënten met AN-R. Wel werd gevonden dat patiënten met

AN-R meer moeilijkheden ondervonden om hun aandacht weg te richten van verwachtte beloning in vergelijking met patiënten met AN-B/P en BN, wat indicatief is voor een hogere beloningsgevoeligheid bij patiënten met AN-R. Omgekeerd vertoonden patiënten met AN-B/P en BN meer moeilijkheden om hun aandacht weg te richten van verwachtte straf in vergelijking met patiënten met AN-R, wat indicatief is voor een hogere strafgevoeligheid bij patiënten met AN-B/P en BN.

Deze bevindingen lijken te impliceren dat het belangrijk is om meer onderzoek te doen met zowel zelfrapportagematen als gedragsmaten van straf- en beloningsgevoeligheid, aangezien beide instrumenten mogelijks andere aspecten van straf- en beloningsgevoeligheid meten. Er moet echter ook rekening gehouden worden met het feit dat de subgroepen binnen studie 2 zeer klein waren, wat de resultaten mogelijks kan beïnvloed hebben. Bovendien werden patiënten met AN-B/P en BN binnen deze studie samengenomen als één subgroep, wat niet het geval was in de voorgaande studie.

Hoofdstuk 4: Straf- en Beloningsgevoeligheid: Zijn Natuurlijk Voorkomende Clusters in deze Trekken Geassocieerd met Eet- en Gewichtsproblemen bij Adolescenten?

De adolescentie is gekend als een periode met een verhoogde kwetsbaarheid voor de ontwikkeling van eetstoornissen (Hoek & Van Hoeken, 2003; Swanson, Crow, Le Grange, Swendsen & Merikangas, 2011; Waaddegaard, Davidsen, & KjØller, 2009). Veel onderzoek richt zich dan ook op mogelijke risicofactoren die bij adolescenten de kans op een eetstoornis kunnen vergroten.

Mogelijks zijn de afwijkingen in straf- en beloningsgevoeligheid die gevonden worden in klinische populaties al aanwezig voor het ontstaan van de eetstoornis en vormen zij risicofactoren. Indien dit inderdaad het geval is, kan men verwachten dat in een kwetsbare groep, zoals adolescenten, verhoogde/verlaagde scores op straf- en beloningsgevoeligheid reeds geassocieerd zijn met verstoord eetgedrag. Eerder onderzoek heeft inderdaad aangetoond dat verhoogde straf- en beloningsgevoeligheid geassocieerd zijn met eetproblemen in studenten (Loxton & Dawe, 2001, 2006). Echter, binnen adolescenten is het onderzoek beperkt. Bovendien ligt de focus meestal op vrouwen, en wordt zelden gekeken naar de associatie tussen straf- en beloningsgevoeligheid enerzijds en verstoord eetgedrag anderzijds bij mannen.

Vertrekkende vanuit deze vaststellingen, was het doel van studie 3 om na te gaan of bepaalde profielen op basis van straf- en beloningsgevoeligheid inderdaad geassocieerd zijn met verstoord eetgedrag bij adolescente jongens en meisjes uit de algemene populatie. Om zicht te krijgen op instrument-specifieke resultaten, werden opnieuw twee verschillende vragenlijsten afgenomen om straf- en beloningsgevoeligheid te meten, zijnde de SPSRQ (Torrubia et al., 2004) en de BIS/BAS Schalen (Carver & White, 1994).

Er werd eerst een clusteranalyse uitgevoerd, waaruit bleek dat er vier profielen konden worden onderscheiden. Deze profielen waren hoge straf- en beloningsgevoeligheid, lage straf- en beloningsgevoeligheid, hoge strafgevoeligheid x lage beloningsgevoeligheid en lage strafgevoeligheid x hoge beloningsgevoeligheid.

Deze profielen bleken, zoals verwacht, geassocieerd te zijn met eetproblemen. Vooral de combinatie van hoge straf- en beloningsgevoeligheid leek samen te hangen met eetproblemen zoals emotioneel eten, lijnen en zorgen over eten, gewicht en lichaamsvorm. Er moet wel opgemerkt worden dat de verschillen met het profiel hoge strafgevoeligheid x lage beloningsgevoeligheid vaak niet significant was.

Extern eten kwam vooral voor bij profielen die gekenmerkt werden door hoge beloningsgevoeligheid, ongeacht het niveau van strafgevoeligheid.

Deze resultaten tonen aan dat ook in een niet-klinische adolescentenpopulatie straf- en beloningsgevoeligheid lijken samen te hangen met eetproblemen. Dit is consistent met de hypothese dat deze trekken kunnen fungeren als risicofactoren.

Hoofdstuk 5: De Rol van Temperament in Symptoomevolutie op Korte Termijn bij Patiënten met een Eetstoornis

In voorgaande hoofdstukken werd aangetoond dat afwijkende niveaus van straf- en beloningsgevoeligheid lijken samen te gaan met eetstoornissen en mogelijks het risico op een eetstoornis verhogen. Het blijft echter onduidelijk of deze trekken een eetstoornis ook mee in stand kunnen houden. Bovendien is het niet duidelijk of deze trekken een individueel effect hebben op eetgedrag, of dat het vooral de interactie tussen verschillende temperamentkenmerken is die van belang is.

Het doel van studie 4 was daarom om na te gaan of (de interactie tussen) straf- en beloningsgevoeligheid voorspellend is voor korte termijn evolutie in eetstoornissymptomen binnen een klinische groep. Aangezien eerder onderzoek ook aantoont dat niet enkel straf- en beloningsgevoeligheid geassocieerd zijn met eetstoornissen, maar ook doorzettingsvermogen, werd ook deze trek mee opgenomen in de huidige studie. Hiervoor werd zowel de SPSRQ (Torrubia et al., 2001) afgenomen, die enkel straf- en beloningsgevoeligheid meet, als de TCI (Cloninger et al., 1993), die ook doorzettingsvermogen in kaart brengt. De steekproef bestond uit patiënten met verschillende types eetstoornissen (AN-R, AN-B/P, BN en BED). Zij werden bevraagd bij intake op het centrum voor eetstoornissen alsook zes maand nadien.

Uit de resultaten bleek dat straf- en beloningsgevoeligheid, gemeten met de SPSRQ, niet voorspellend waren voor de evolutie in verschillende eetstoornissymptomen. Wel werd, tegen de verwachtingen in, gevonden dat hogere strafgevoeligheid meer gewichtstoename voorspelde bij patiënten met ondergewicht. Op basis van de TCI echter werd gevonden dat de combinatie van lagere strafgevoeligheid en hogere beloningsgevoeligheid voorspellend was voor een afname in lijngedrag Bovendien werd gevonden dat lagere scores op straf- en beloningsgevoeligheid in combinatie met lagere scores op doorzettingsvermogen voorspellend waren voor een afname in eetbuien en/of purgeergedrag en lichaamsontevredenheid.

Dit betekent dat de resultaten niet eenduidig waren en dat meer onderzoek nodig is om de onverwachte resultaten uit te klaren. Desondanks werd er enige evidentie gevonden voor de hypothese dat de interactie tussen verschillende temperamentskenmerken een mogelijke instandhoudende rol speelt in eetstoornissymptomen.

Hoofdstuk 6: Effortful Control als Moderator in het Verband tussen Straf- en Beloningsgevoeligheid en Eetstijlen bij Adolescente Jongens en Meisjes

Zoals eerder aangegeven, is de adolescentie een kwetsbare periode voor de ontwikkeling van eetstoornissen. Bovendien blijkt uit studie 3 dat bepaalde temperamentprofielen op basis van straf- en beloningsgevoeligheid reeds geïmpliceerd zijn in eetproblemen bij adolescenten. Zowel deze bevinding alsook de bevinding uit studie 4 dat de interactie tussen verschillende trekken mogelijks eetstoornissymptomen beïnvloedt, suggereert dat ook bij adolescenten de interactie tussen verschillende temperamentkenmerken belangrijk kan zijn om het inzicht in het ontstaan van eetproblemen te vergroten.

Dit is ook consistent met de eerder vernoemde modellen van psychopathologie. Zo wordt onder meer gesteld dat psychopathologie ontstaat door de interactie tussen reactieve trekken, zoals straf- en beloningsgevoeligheid, enerzijds en regulatieve trekken, zoals *Effortful Control* (EC), anderzijds (Lonigan, et al., 2004; Nigg, 2006; Nigg, et al., 2005). EC verwijst naar het vermogen van een individu om vrijwillig de aandacht te focussen of te verleggen (= aandachtscontrole), om gedrag te inhiberen (= inhiberende gedragscontrole) en om gedrag te activeren wanneer dit nodig is (= activerende gedragscontrole) (Rothbart, 1989; Rothbart & Ahadi, 1994). Vanuit het neuropsychologisch perspectief verstaat men hieronder ook het vermogen om een bepaald responspatroon aan te houden ondanks de aanwezigheid van afleidende stimuli (= interferentiecontrole), het vermogen om bepaalde informatie uit te sluiten van het werkgeheugen door deze informatie actief te onderdrukken (= cognitieve inhibitie) en het vermogen om intentioneel een gedragsmatige respons uit te stellen (= motorische inhibitie) (Nigg, 2000; Nigg, et al., 2005).

Binnen studie 5 werden twee maten afgenomen van EC: een algemene vragenlijst die peilt naar de combinatie van aandachtscontrole, inhiberende en activerende gedragscontrole, en een gedragstaak die peilt naar interferenctiecontrole. Het doel van deze studie was om na te gaan of EC een modererende rol speelt in het verband tussen straf- en beloningsgevoeligheid enerzijds en verstoord eetgedrag bij adolescenten anderzijds. Dit werd apart onderzocht bij jongens en meisjes uit de algemene populatie.

Er werd geen evidentie gevonden dat EC een moderator zou zijn tussen straf- en beloningsgevoeligheid en verstoord eetgedrag bij jongens. Bij meisjes echter bleek interferentiecontrole een modererende rol te spelen in het verband tussen zowel strafgevoeligheid als beloningsgevoeligheid en restrictief eetgedrag. Bovendien bleek algemene EC een modererende rol te spelen in het verband tussen strafgevoeligheid en emotioneel eten.

Op basis van deze resultaten lijkt het belangrijk om meer onderzoek te doen naar de rol die verschillende componenten van EC kunnen spelen in het verband tussen reactieve temperamentkenmerken en verstoord eetgedrag.

Hoofdstuk 7: Discussie en Conclusies

Belangrijkste bevindingen

Strafgevoeligheid. Over de studies heen waren de resultaten grotendeels in overeenstemming met de hypothese dat verhoogde strafgevoeligheid geassocieerd is met eetstoornissymptomen, dat dit de kwetsbaarheid voor een verstoord eetgedrag in de adolescentie mogelijks vergroot en dat deze trek mogelijks een instandhoudende factor is in eetstoornissymptomen. Er werd ook gevonden dat de associatie tussen strafgevoeligheid en verstoord eetgedrag deels afhankelijk is van andere modererende trekken. Er moet echter ook opgemerkt worden dat daarnaast enkele resultaten gevonden werden die in tegenstrijd zijn met deze algemene conclusie, zoals de bevinding dat strafgevoeligheid positief geassocieerd is met gewichtstoename bij patiënten met AN (studie 4).

Beloningsgevoeligheid. Met betrekking tot beloningsgevoeligheid werd eveneens evidentie gevonden dat deze trek geassocieerd is met eetstoornissymptomen. Afhankelijk van de eetstoornisdiagnose werden verschillende niveaus van beloningsgevoeligheid gevonden, deze trek lijkt ook bij adolescenten samen te hangen met verstoord eetgedrag, en lijkt, in interactie met andere trekken, ook voorspellend te zijn voor de evolutie in bepaalde eetstoornissymptomen. Echter, de aard van het verband was minder eenduidig. Zo was er enerzijds evidentie dat beloningsgevoeligheid geassocieerd is met meer toenaderingsgedrag naar voeding. Bijvoorbeeld, in studie 1 werd een hogere beloningsgevoeligheid gevonden in patiënten met BN in vergelijking met patiënten met AN-R. Hoge beloningsgevoeligheid is bovendien ook geassocieerd met extern eten bij niet-klinische adolescenten in studie 3. In studie 4 werden tevens een aantal interactie-effecten gevonden die in lijn waren met deze hypothese. Anderzijds werd er ook evidentie gevonden voor hogere beloningsgevoeligheid in patiënten met AN-R vergeleken met patiënten met AN-B/P of BN op basis van een gedragsmaat van beloningsgevoeligheid (studie 2). Bovendien bleek de manier waarop beloningsgevoeligheid samenhing met eetstoornissymptomen ook te verschillen afhankelijk van het niveau van andere modererende trekken en afhankelijk van de al dan niet klinische aard van de steekproef. Er kan dus besloten worden dat de resultaten consistent zijn met de hypothese dat beloningsgevoeligheid mogelijks een rol speelt als risico- en instandhoudende factor voor eetstoornissen. Echter, de aard van het verband tussen beloningsgevoeligheid en verstoord eetgedrag blijkt afhankelijk van welk aspect van beloningsgevoeligheid gemeten wordt, van welke symptomen onderzocht worden, de al dan niet klinische aard van de steekproef en de aanwezigheid van modererende trekken.

Implicaties voor toekomstig onderzoek

Deze resultaten hebben verschillende implicaties voor toekomstig onderzoek. Zo is meer onderzoek naar en een duidelijkere definiëring van de concepten impulsiviteit, prikkelzoekendheid en beloningsgevoeligheid nodig. Het lijkt ook belangrijk om nieuwe vragenlijsten te ontwikkelen om deze trekken te meten en om daarnaast ook meer gedragsmaten te gebruiken. Om meer inzicht te krijgen in de mogelijks causale rol die straf- en beloningsgevoeligheid kunnen spelen in eetstoornissen zijn longitudinale cohort studies nodig. Daarnaast lijkt het zinvol om in toekomstig onderzoek meer moderatoren, zoals doorzettingsvermogen en EC, op te nemen. Een bijkomende hypothese die verder onderzoek vergt, is dat niet enkel het algemene niveau van straf- en beloningsgevoeligheid afwijkend is bij patiënten met een eetstoornis, maar dat er ook een verandering optreedt in welke stimuli als straf of beloning ervaren worden (Keating, 2010; Keating, Tilbrook, Rossell, Enticott & Fitzgerald, 2012; Södersten, Nergardh, Bergh, Zandian, & Scheurink, 2008).

Klinische implicaties

De resultaten van dit proefschrift houden ook enkele klinische implicaties in. Zo is het mogelijk dat het trainen van aandachtsprocessen en van EC efficiënt zou kunnen zijn om de invloed van straf- en beloningsgevoeligheid op eetgedrag te bufferen. Hiervoor is uiteraard eerst meer onderzoek nodig, o.a. naar welke aspecten van EC functioneren als protectieve factoren en voor welk specifiek temperamentsprofiel dat het geval is. Daarnaast lijkt het ook zo te zijn dat temperamentsprofielen, eerder dan scores op afzonderlijke trekken, belangrijk kunnen zijn voor screeningsdoeleinden. Gebaseerd op de bevinding dat strafgevoeligheid positief geassocieerd lijkt te zijn met verstoord eetgedrag, lijkt het ook belangrijk dat therapeuten hier rekening mee houden in hun eigen houding tegenover patiënten. Patiënten met een eetstoornis zijn vermoedelijk sneller angstig en ervaren vermoedelijk veel uitspraken sneller als kritiek ten gevolge van hun verhoogde strafgevoeligheid. In een angstige toestand is het moeilijker om nieuw gedrag aan te leren. Dit betekent mogelijks dat therapeuten extra aandacht dienen te besteden aan het voorkomen van al te angstinducerende situaties. Dit kan een grote uitdaging vormen gezien ook therapeuten vaak machteloosheid ervaren ten gevolge van de verhoogde rigiditeit van patiënten met een eetstoornis.

Besluit

Op basis van het huidige proefschrift kan besloten worden dat het niveau van straf- en beloningsgevoeligheid verschillend is bij patiënten met een eetstoornis. Bovendien blijken deze trekken ook in niet-klinische adolescentenpopulaties reeds samen te hangen met verstoord eetgedrag en zijn deze trekken mogelijks ook voorspellend voor de evolutie in eetstoornissymptomen. De manier waarop straf- en beloningsgevoeligheid samenhangen met verstoord eetgedrag wordt mogelijks ook beïnvloed door andere trekken, zoals doorzettingsvermogen en EC. Verder onderzoek is nodig om de huidige bevindingen te repliceren en uit te breiden.

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Data Storage Fact Sheets

Data Storage Fact Sheet

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If a response is not received when using the above contact details, please send an email to data.pp@ugent.be or contact Data Management, Faculty of Psychology and Educational Sciences, Henri Dunantlaan 2, 9000 Ghent, Belgium.
2. Information about the datasets to which this sheet applies

===

* Reference of the publication in which the datasets are reported: Matton, A., Goossens, L., Vervaet, M., & Braet, C. (2015). Temperamental Differences between Adolescents and Young Adults with or without an Eating Disorder. *Comprehensive Psychiatry, 56,* 229-238. doi: 10.1016/j.comppsych.2014.09.005.
* Which datasets in that publication does this sheet apply to?: The sheet applies to all the data used in the publication.

3. Information about the files that have been stored
==

3a. Raw data
----

* Have the raw data been stored by the main researcher? [x] YES / [ ] NO
If NO, please justify:

* On which platform are the raw data stored?
- [x] researcher PC
- [x] research group file server
- [ ] other (specify): ...

* Who has direct access to the raw data (i.e., without intervention of another person)?
- [x] main researcher
- [ ] responsible ZAP
- [ ] all members of the research group
- [ ] all members of UGent

- [x] other (specify): IT worker Steven Vandenhole

3b. Other files
----

* Which other files have been stored?
-[X]file(s) describing the transition from raw data to reported results. Specify: Scale scores
-[ ] file(s) containing processed data. Specify: ...
-[x] file(s) containing analyses. Specify: Output files (SPSS).
-[x] files(s) containing information about informed consent (blank copy of the informed consent form)
-[x] a file specifying legal and ethical provisions: The documents that were submitted to the Ethical Commission are on my PC. I have an e-mail with the approval of the Ethical Commission and my promoter Prof. Dr. Caroline Braet has a paper letter with the approval of the Ethical Commission.
-[ ] file(s) that describe the content of the stored files and how this content should be interpreted. Specify: ...
-[x] other files. Specify: SPSS syntaxes describing the transition from the raw data to the processed data.

* On which platform are these other files stored?
- [x] individual PC
- [x] research group file server
- [ ] other: ...

* Who has direct access to these other files (i.e., without intervention of another person)?
- [x] main researcher

- [ ] responsible ZAP
- [ ] all members of the research group
- [ ] all members of UGent
- [x] other (specify): IT worker Steven Vandenhole

4. Reproduction
===

* Have the results been reproduced independently?: [ ] YES / [x] NO

* If yes, by whom (add if multiple):
- name:
- address:
- affiliation:
- e-mail:

Data Storage Fact Sheet

Name/identifier study: Chapter 3 PhD Annelies Matton
Author: Annelies Matton
Date: 26/03/2017

1. Contact details
===
1a. Main researcher

- name: Annelies Matton
- address: De Pintelaan 185, 9000 Gent
- e-mail: Annelies.matton@UzGent.be

1b. Responsible Staff Member (ZAP)

- name: Prof Dr. Caroline Braet and Prof. Dr. Lien Goossens
- address: Henri Dunantlaan 2, 9000 Gent
- e-mail: Caroline.Braet@UGent.be
- e-mail: Lien.Goossens@UGent.be

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2. Information about the datasets to which this sheet applies
===

* Reference of the publication in which the datasets are reported: Matton, A., de Jong, P., Goossens, L., Jonker, N., Vervaet, M., De Schryver, N., & Braet, C. (under review). Sensitivity for Cues Predicting Reward and Punishment in Young Women with Eating Disorders. European Eating Disorders Review.
* Which datasets in that publication does this sheet apply to?: The sheet applies to all the data used in the publication.

3. Information about the files that have been stored
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- [x] research group file server
- [ ] other (specify): ...

* Who has direct access to the raw data (i.e., without intervention of another person)?
- [x] main researcher
- [ ] responsible ZAP
- [ ] all members of the research group
- [ ] all members of UGent

- [x] other (specify): IT worker Steven Vandenhole

3b. Other files
----

* Which other files have been stored?
-[x]file(s) describing the transition from raw data to reported results. Specify: Scale scores
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4. Reproduction
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* Have the results been reproduced independently?: [ ] YES / [x] NO

* If yes, by whom (add if multiple):
- name:
- address:
- affiliation:
- e-mail:

Data Storage Fact Sheet

Name/identifier study: Chapter 4 PhD Annelies Matton
Author: Annelies Matton
Date: 26/03/2017

1. Contact details
==
1a. Main researcher

- name: Annelies Matton
- address: De Pintelaan 185, 9000 Gent
- e-mail: Annelies.Matton@UzGent.be

1b. Responsible Staff Member (ZAP)

- name: Prof Dr. Caroline Braet and Prof. Dr. Lien Goossens
- address: Henri Dunantlaan 2, 9000 Gent
- e-mail: Caroline.Braet@UGent.be
- e-mail: Lien.Goossens@UGent.be

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2. Information about the datasets to which this sheet applies
===

* Reference of the publication in which the datasets are reported: Matton, A., Goossens, L., Braet, C., & Vervaet, M. (2012). Punishment and Reward Sensitivity: Are Naturally Occurring Clusters in these Traits Related to Eating and Weight Problems in Adolescents? European Eating Disorders Review, 21, 184-194. doi: 10.1002/erv.2226.
* Which datasets in that publication does this sheet apply to?: The sheet applies to all the data used in the publication.

3. Information about the files that have been stored
==

3a. Raw data
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* Have the raw data been stored by the main researcher? [x] YES / [ ] NO
If NO, please justify:

* On which platform are the raw data stored?
- [x] researcher PC
- [x] research group file server
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* Who has direct access to the raw data (i.e., without intervention of another person)?
- [x] main researcher
- [ ] responsible ZAP
- [ ] all members of the research group

- [ ] all members of UGent
- [x] other (specify): IT worker Steven Vandenhole

3b. Other files
----

* Which other files have been stored?
-[ ]file(s) describing the transition from raw data to reported results. Specify: ...
-[x] file(s) containing processed data. Specify: scale scores.
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* If yes, by whom (add if multiple):
- name:
- address:
- affiliation:
- e-mail:

Data Storage Fact Sheet

Name/identifier study: Chapter 5 PhD Annelies Matton
Author: Annelies Matton
Date: 26/03/2017

1. Contact details
===
1a. Main researcher

- name: Annelies Matton
- address: De Pintelaan 185, 9000 Gent
- e-mail: Annelies.Matton@UzGent.be

1b. Responsible Staff Member (ZAP)

- name: Prof Dr. Caroline Braet and Prof. Dr. Lien Goossens
- address: Henri Dunantlaan 2, 9000 Gent
- e-mail: Caroline.Braet@UGent.be
- e-mail: Lien.Goossens@UGent.be

If a response is not received when using the above contact details, please send an email to data.pp@ugent.be or contact Data Management, Faculty of Psychology and Educational Sciences, Henri Dunantlaan 2, 9000 Ghent, Belgium.

2. Information about the datasets to which this sheet applies
===

* Reference of the publication in which the datasets are reported: Matton, A., Goossens, L., Vervaet, M., & Braet, C. The role of temperament in short-term symptom evolution in patients with an eating disorder. Unpublished results
* Which datasets in that publication does this sheet apply to?: The sheet applies to all the data used in the publication.

3. Information about the files that have been stored
===

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- [x] other (specify): IT worker Steven Vandenhole

3b. Other files

----

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- [x] other (specify): IT worker Steven Vandenhole

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* If yes, by whom (add if multiple):
- name:
- address:
- affiliation:
- e-mail:

Data Storage Fact Sheet

Name/identifier study: Chapter 6 PhD Annelies Matton
Author: Annelies Matton
Date: 26/03/2017

1. Contact details
==
1a. Main researcher

- name: Annelies Matton
- address: De Pintelaan 185, 9000 Gent
- e-mail: Annelies.Matton@UzGent.be

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* Which datasets in that publication does this sheet apply to?: The sheet applies to all the data used in the publication.

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